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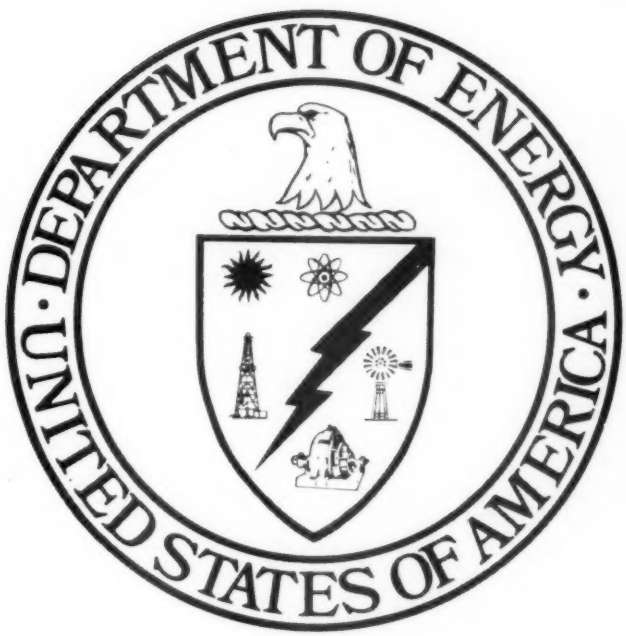

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CORRECTIONS

ERA Vol. 2, No. 9, Abst. 21981, line 1 should read: (DSE/2426-1) Alternative energy transmission systems

ERA Vol. 2, No. 18, Abst. 42948, line 1 should read: (CENPD-206) TORC code: verification and simplified

ERA Vol. 2, No. 20, Abst. 50080, line 6 should read: ENG-26; NLM-INA-40-274-71. 101p. Dep. NTIS, PC E10/MF A01

ERA Vol. 2, No. 21, Abst. 53472, line 1 should read: (EPRI-115-2(Ph.3)) Fusion reactor studies: Doublet III design.

ERA Vol. 2, No. 24, Abst. 59728, line 1 should read: (NEDO-21617-1) Analog transmitter/trip unit system for

ERA Vol. 2, No. 24, Abst. 61292, line 1 should read: (CONF-770736-1) Test of quark-line rule and nonet mass formu-

ERA Vol. 2, No. 24, Abst. 61292, lines 3 and 4 should read: Astronomy). 23 Jun 1977. Contract EY-76-C-02-3065. 17p. Dep. NTIS, PC A02/MF A01.

ERA Vol. 2, No. 24, Abst. 61801, line 1 should read: (EPRI-115-2(Ph.2)) Fusion reactor studies: potential of low Z

ERA Vol. 3, No. 2, Abst. 4532 should be replaced with:

The molar absorbance, ϵ, of several lots of TATB in DMSO at 355 nm was measured. It ranged from 2.80×10^4 to 2.84×10^4. Beer's law applies up to at least 0.36 mg of TATB/25 ml (5.6×10^{-5}M). Attempts to enhance the sensitivity of the photometric method by using specific reagents for polynitroaromatic compounds have failed.

Volume 3, Number 15, August 15, 1978

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(BAW—10074A(Rev.1))
Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.
Qualification of submerged-arc narrow strip cladding process, 1:16557 (BAW—10108A)

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Ackermann, A., Excitation functions of the (n,2n) reactions of ^{12}C and ^{238}U, 1:18034
Ackley, M.H., *See* Derr, V.E., 1:17257
Acton, J.P., *See* Mitchell, B.M., 1:16369
Adam, J.C., *See* Gitomer, S.J., 1:18301
Adams, A.A., *See* Barger, H.J. Jr., 1:16409
Adams, M.S., *See* Titus, J., 1:17363

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DIETHYLENETRIAMINEPENTAACETIC ACID
See DTPA
DIFFERENTIAL EQUATIONS
See also KORTEWEG-DE VRIES EQUATION
SCHROEDINGER EQUATION
DIFFERENTIAL EQUATIONS/ANALYTICAL SOLUTION
Singular solution of the capillary equation. I. Existence, 1:18384
Singular solution of the capillary equations. II. Uniqueness, 1:18385

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ENERGY RESEARCH ABSTRACTS

COAL AND COAL PRODUCTS

34326 (NP—22625) **Wyoming coal directory. Public Information Circular 5.** Glass, G.B. (comp.). (Wyoming Geological Survey, Laramie (USA)). Jul 1976. 23p. Survey of Wyoming, Laramie.

PROCESSING

REFER ALSO TO CITATION(S) 34421, 35736

34327 (ORNL/TM—6210) **Nondestructive inspection of thin plasma-sprayed ceramic and cermet protective coatings for coal conversion and utilization equipment.** Scott, G.W.; Cook, K.V.; Davis, E.V.; Dodd, C.V.; Foster, B.E.; Mason, W.J.; McClung, R.W.; Simpson, W.A. Jr.; Snyder, S.D. (Oak Ridge National Lab., Tenn. (USA)). Apr 1978. Contract W-7405-ENG-26. 89p. Dep. NTIS, PC A05/MF A01.

Results of a project to develop nondestructive inspection techniques for ceramic and cermet wear- and process-resistant coatings used in coal system compounds are described. The general inspection problem has been analyzed and the difficulties peculiar to plasma-sprayed coatings are discussed. Physical properties, especially porosity, and the nominal 0.25 mm thickness make the inspection of these coatings difficult. The literature has been reviewed for inspection methods and technology adaptable to coating inspection. Several inspection methods have been evaluated for feasibility by laboratory experiments. The basic coating defect conditions considered are cracks or holes, variations in thickness, lamellar separations, and inhomogeneities. Assessment of current technology indicates that a few nondestructive methods can be applied directly to the inspection of coatings with very little development; in most cases, however, considerable development is required.

CARBONIZATION

34328 (FE—1220-30) **CLEAN COKE process: process development studies. Report for third quarter 1977.** (USS Engineers and Consultants, Inc., Pittsburgh, Pa. (USA)). Nov 1977. Contract EX-76-C-01-1220. 24p. Dep. NTIS, PC A02/MF A01.

The carbonization PDU was operated to process West Kentucky coal through both stages of carbonization, at 820°F and at 1400 and 1470°F. Weight-balance data for the 820°F run showed an accountability of 99.2 percent. The 3-inch continuous carbonizer was operated to establish optimum PDU conditions for processing Pittsburgh coal. In the hydrogenation area, a comparison was made of vapor stripping and vacuum distillation as techniques for separating oil from coal-conversion effluent. In the binder-preparation area, tests were made to improve the properties of binder materials for cokemaking. Tests included air blowing and/or heat soaking. A method was devised for evaluating binders in small coke specimens prior to their use in pelletizing tests. Pelletization runs were made in the cokemaking area with pulverized Illinois char and several binders: C-12 tar and SRC fluxed with hydrogenated heavy creosote in various proportions. The coking kiln was returned to service in September following extensive work on the auxiliary burners and the ceramic lining in the burner area. Four batches of cured pellets were calcined.

34329 **Rheinbraun research on coal processing.** Speich, P. *Bergbau;* **28**: No. 9, 361-364(Sep 1977). (In German).

Research and development work in the FRG on brwon coal utilization are outlined. This includes methods for the preparation of culm coke and formed coke as well as gasification methods. Mention is also made of the use of nuclear process heat. Finally, the competitive situation and the overall economic situation are gone into.

DESULFURIZATION AND PURIFICATION

REFER ALSO TO CITATION(S) 34473, 34474, 34923, 34924, 34925, 34927, 34928

34330 (CONF-7710113—, pp 1-9) **Desulfurization of coal by oxidation in alkaline solutions.** Tai, C.Y.; Graves, G.V.; Wheelock, T.D. (Iowa State Univ., Ames). 1977.

From 3. symposium on coal preparation; Louisville, KY, USA (18 Oct 1977).

In Third symposium on coal preparation.

Several processes have been proposed for extracting sulfur from coal by leaching the crushed and ground material with hot aqueous solutions containing dissolved oxygen. Generally, it has been proposed to utilize acidic solutions since sulfuric acid is generated in such processes through oxidation of the pyritic sulfur. However, more recently the proposal has been made to use a basic solution of aqua ammonia. Apparently by employing a basic solution, a significant part of the organic sulfur can be removed from coal as well as the inorganic sulfur at relatively moderate temperatures (e.g., 130°C), whereas higher temperatures (150 to 200°C) seem to be required for removing organic sulfur with acidic solutions. Basic solutions containing dissolved oxygen also offer the advantage of attacking pyrite more rapidly than acidic solutions. The experimental results of this study clearly show that dilute alkaline solutions containing oxygen dissolved under pressure are very effective at elevated temperatures for extracting inorganic sulfur from coal. Moreover, among various alkalis tested, sodium carbonate seems to be the most effective. In addition, this material has the advantages of being readily available, low in cost, and relatively noncorrosive in aqueous solutions towards steel and other common materials of construction. Furthermore, chemical leaching can be combined advantageously with physical cleaning since the latter is better suited for removing coarser particles of pyrite while the former is better suited for removing the microscopic particles.

34331 (CONF-7710113—, pp 10-21) **Microbiological removal of sulfur from a pulverized coal blend.** Dugan, P.R.; Apel, W.A. (Ohio State Univ., Columbus). 1977.

From 3. symposium on coal preparation; Louisville, KY, USA (18 Oct 1977).

In Third symposium on coal preparation.

The purpose of this report is to further demonstrate microbiological desulfurization of coal in the laboratory as an illustration of its potential for scale up to a commercial process. The phrases: pyrite oxidation, sulfur oxidation, solubilization of pyritic minerals and release of sulfate are all equivalent to removal of pyritic sulfur from coal by a solubilization and leaching process. Sulfate production can be due to oxidation and solubilization of either pyritic or organic sulfur. The effects of particle size and the time necessary for sulfur removal (about 2 weeks) in various microbial inocula were investigated.

34332 (FE—2449-4) **Studies in support of recirculating bed reactors for the processing of coal. Annual report, June 1, 1976—October 31, 1977.** Bierl, T.W.; Massey, M.J.; McIver, A.E.; Gajdos, L.J.; McGovern, J.J. (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA)). Oct 1977. Contract EX-76-C-01-2449. 154p. Dep. NTIS, PC A08/MF A01.

Coal Mixer Modelling Studies is an experimental program created to examine physical mixing of densely entrained gas-solids streams in a plastic model of an RBR. The report describes the scope of the mixing problem (including its relevance to the processing of agglomerating coals), the objectives of the current program, and the

apparatus designed to implement the experimental program. Preliminary data, which have been gathered to evaluate the equipment and the special instrumentation, are presented. Coal Hydrodesulfurization Studies seeks to achieve two objectives: a process objective and a chemistry objective. The process objective examines the potential for hydrodesulfurization (organic sulfur) of eastern agglomerating coals. The conditions to be studied include rapid heating of coal, high partial pressures of hydrogen relative to hydrogen sulfide, moderate pressure of 10 to 20 atm, and temperatures in the range from 750°C to 950°C. The data is to be of sufficient quality that it can be used to design an RBR process development unit. The second objective pursues a greater understanding of the coal sulfur chemistry. This will be accomplished by conducting experiments in a well characterized reactor. A reactor meeting this criterion has been designed and constructed, and is currently being evaluated. Design criteria and descriptions of the equipment are contained in the report.

GASIFICATION

REFER ALSO TO CITATION(S) 34329, 34394, 34399, 34401, 34409, 34422, 34482, 34841, 35652

34333 (ANL—78-7) **Proceedings of the 1977 symposium on instrumentation and process control for fossil demonstration plants.** (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 495p. (CONF-770729—). Dep. NTIS, PC A22/MF A01.

From Symposium on instrumentation and control for fossil demonstration plants; Chicago, IL, USA (13 Jul 1977).

The 1977 Symposium on Instrumentation and Process Control for Fossil Demonstration Plants was held at Hyatt Regency O'Hare, Chicago, Illinois, July 13 to 15, 1977. It was sponsored by the Argonne National Laboratory, the U.S. Energy Research and Development Administration and the Instrument Society of America (Chicago Section). Seventeen papers from thee proceedings were entered individually into EDB and ERA (three papers weree entered previously). (LTN)

34334 (ANL—78-7, pp 18-49) **Instrumentation development and application at the Westinghouse coal gasification PDU.** Macko, J.E.; Salvador, L.A.; Cherish, P.; Haldipur, G. (Westinghouse Research and Development Center, Madison, PA). 1977.

From Symposium on instrumentation and control for fossil demonstration plants; Chicago, IL, USA (13 Jul 1977).

In Proceedings of the 1977 symposium on instrumentation and process control for fossil demonstration plants.

The tests being performed with the gasification PDU have three primary goals: to develop an efficient, operable process; to produce process design and operating data for use in scaling up to commercial plants; and to develop and evaluate hardware and subsystem designs which may be used in scaled-up plants. Part of the third goal is the evaluation of instrumentation and control systems to permit a selection of acceptable components for larger scale gasification plants. This evaluation consists, in the main, of utilizing off-the-shelf components and adapting them to the special application and hostile environments found in a typical coal conversion plant. This adaptation sometimes requires either a redesign of the basic instrument or the design of a suitable interface to the process. In addition to the adaptation and evaluation of state-of-the-art instrumentation, it has often been necessary to develop special purpose instruments. This has been required in situations for which no instruments are commercially available to adequately perform the measurement or control task or in those for which existing instruments do not perform as planned because of the conditions actually encountered in the plant. The problems encountered in the use of standard electronic and pneumatic sensors, transmitters, recorders, and controllers have generally been related to the interfacing of these components to the process and not in the operation of the units themselves which, in the case of the electronic instruments, have had excellent performance. High temperature thermocouples initially failed frequently but these problems were solved by a careful selection of sheath, well, and insulator materials to optimize their performance in both oxidizing and reducing atmospheres.

34335 (ANL—78-7, pp 81-87) **Overview of ERDA-fossil energy demonstration plant program.** Rial, G.A. (Energy Research and Development Administration, Washington, DC). 1977.

From Symposium on instrumentation and control for fossil demonstration plants; Chicago, IL, USA (13 Jul 1977).

In Proceedings of the 1977 symposium on instrumentation and process control for fossil demonstration plants.

US ERDA's demonstration plant program is described. So far this joint industry/government program involves several coal gasification plants producing low, intermediate or high Btu fuel gas by gasification processes proved through the pilot plant stage. Other proposals for shale oil and synthetic fuels are under development. The need for greatly improved controls and instrumentation in these plants is stressed: For mass and heat balance; for safety, reliability and problem diagnosis; and for control of environmental effects. (LTN)

34336 (ANL—78-7, pp 90-125) **Review of the state-of-the-art of flow and analysis instruments.** O'Fallon, N.M.; Duffey, D.; Herzenberg, C.L.; Managan, W.W.; Porges, K.G.; Raptis, A.C. 1977.

From Symposium on instrumentation and control for fossil demonstration plants; Chicago, IL, USA (13 Jul 1977).

In Proceedings of the 1977 symposium on instrumentation and process control for fossil demonstration plants.

Comparative evaluations are made of flowmeters for possible use in measuring coal gasification plant flow streams involving multiphase flow. Gas chromatography and mass spectroscopy are discussed in less detail as instruments for analyzing the composition of gas streams. The possibilities of neutron activation analysis for determining the content of sulfur, moisture, iron and silicon in coal streams flowing inside pipes are discussed. Finally, a calorimeter for monitoring the calorific value of fuel gas is mentioned. (LTN)

34337 (ANL—78-7, pp 127-134) **BI-GAS Pilot Plant experience in mass flow measurement.** Miles, J.M. (Phillips Petroleum Co., Homer City, PA). 1977.

From Symposium on instrumentation and control for fossil demonstration plants; Chicago, IL, USA (13 Jul 1977).

In Proceedings of the 1977 symposium on instrumentation and process control for fossil demonstration plants.

The Model 60 Thermal Flow Meter as supplied by Thermal Instrument Company is the flow measuring device used in each of the coal and char feed lines. The flow meter is the same internal diameter as the feed line and presents an unobstructed flow area. Extremely accurate temperature sensors are located in the wall of the meter before and after an electrical heating device. The temperature sensors never directly contact the flowing material. An upstream sensor measures temperature of the process stream. The downstream temperature sensor is maintained at a fixed temperature increment above the upstream temperature with an electrical power input. The voltage or power required to maintain the fixed temperature increment is proportional to mass flow rate. Flow measurement with the thermal flow meter will be dependent on ambient temperature, process temperature and transport properties of the coal or char. The instrument contains automatic temperature compensation circuits but calibration at or near process conditions is required. There is no compensation for variations in transport properties of coal or char. These thermal flow meters do show a response to solids flow through the coal and char feed lines. Additional testing at process conditions is needed to determine if the meters provide reliable quantitative measurements.

34338 (ANL—78-7, pp 136-160) **Instrumentation of a Wellman—Galusha gasifier operating on anthracite for system evaluation and control.** Maurer, R.E. (Acurex Corp., Mountain View, CA); Dammann, R.W. 1977.

From Symposium on instrumentation and control for fossil demonstration plants; Chicago, IL, USA (13 Jul 1977).

In Proceedings of the 1977 symposium on instrumentation and process control for fossil demonstration plants.

This ERDA program will establish on a timely basis the operational details of a 10-foot diameter Wellman-Galusha gasifier supplying fuel for an industrial brick kiln. Instrumentation techniques will be developed, tried, and evaluated. The measurement techniques and operational data will enable both ERDA and Glen-Gery Corporation to accurately evaluate the efficiency of anthracite gasification. Data from this program will enable the government (via ERDA) to evaluate and promote low-Btu producer gas from anthracite as an alternate fuel for other industrial processes throughout the northeastern part of the United States.

34339 (ANL—78-7, pp 197-205) **Future of coal gasification in Illinois: the utilities point of view.** Eby, R.J. (Illinois Coal Gasification Group, Chicago). 1977.

From Symposium on instrumentation and control for fossil demonstration plants; Chicago, IL, USA (13 Jul 1977).

In Proceedings of the 1977 symposium on instrumentation and process control for fossil demonstration plants.

It is absolutely essential that we are able to measure all the variables in these new coal gasification processes. Control equipment and systems will be a major element in the design of commercial scale coal gasification plants. Process computer control will be as common in coal gasification plants as pneumatic and electronic controls are in today's chemical plants. Therefore, this general concept of process computer control must be integrated into the development of new systems designed for the use of coal conversion industry. Coal gasification plants, as with other process plants, are composed of a series of unique operations combined to form an overall process. One of the key areas in the success of any coal gasification project will be the ability to move, in a controlled manner, run of mine coal through several operations and be properly sized to enter a gasifier at elevated temperature and pressure. We

feel that it is in this area of solids movement that the need for improved instrumentation is the greatest.

34340 (ANL—78-7, pp 274-285) **Requirements for on-line composition analysis of coal gasification process streams using optical methods.** Walsh, J.V. (C. F. Braun and Co., Alhambra, CA). 1977.

From Symposium on instrumentation and control for fossil demonstration plants; Chicago, IL, USA (13 Jul 1977).

In Proceedings of the 1977 symposium on instrumentation and process control for fossil demonstration plants.

Adaptation of instruments using radiation may answer the need for composition analyzers in coal gasification process streams. Such instruments would use radiation in the range of 200 NM in the ultraviolet to 15 μM in the infrared. The use of both emission and absorption principles has been widely used in process applications and should be adaptable to the analytical and environmental constraints of the coal-related processes. The principal components of interest are steam, carbonyl sulfide, and oxides of nitrogen, carbon and sulfur, hydrogen sulfide, oxygen, methane, hydrochloric acid, and total hydrocarbons. Requirements for these analyzers are reviewed in detail.

34341 (ANL—78-7, pp 324-347) **State-of-the-art of instrumentation for high temperature thermometry.** Schooley, J.F. (National Bureau of Standards, Washington, DC). 1977.

From Symposium on instrumentation and control for fossil demonstration plants; Chicago, IL, USA (13 Jul 1977).

In Proceedings of the 1977 symposium on instrumentation and process control for fossil demonstration plants.

Innovations in the practice of high-temperature thermometry which appear to be relevant to the problems evident in modern coal conversion processes are discussed. In steady-state measurements where one can tolerate the relatively slow response times which accompany the use of thermowells, the installation of carefully prepared modern thermocouples such as Nicrosil-Nisil, Type B, and tungsten-rhenium alloys can provide extended-term, accurate service. The Johnson noise thermometer, too, has been demonstrated to be an extended-life, highly accurate, high temperature instrument. The extent to which it will satisfy existing needs for fast thermal response, however, is uncertain. The acoustical thermometer can take many forms, using gaseous, liquid, or solid sensors; the solid sensors may be metals or insulators. Either timed-pulse or resonant-frequency detection methods may be used. The acoustical thermometer is thus a versatile technique. Its usefulness for extended-term, high temperature measurements has yet to be demonstrated, however, and it appears that the sensor must remain free from either internal or external attack by its environment in order to realize that goal. The use of radiation pyrometry for accurate, extended-term measurements appears to depend upon a rigorous calibration technique. Presently-available thermal imaging techniques can serve the needs for "hot-spot" detection, owing to thin or defective insulation or partially plugged lines, serving both as a safety measure and as a significant energy conservation technique.

34342 (ANL—78-7, pp 368-389) **BI-GAS high temperature thermocouples: design considerations and operating experience.** Pitcher, N.D. (Stearns-Roger, Inc., Homer City, PA). 1977.

From Symposium on instrumentation and control for fossil demonstration plants; Chicago, IL, USA (13 Jul 1977).

In Proceedings of the 1977 symposium on instrumentation and process control for fossil demonstration plants.

310 s.s. thermowells have performed without failure in the BI-GAS Stage II environment. Current plans are to also evaluate 310 s.s. Alonized, 446 s.s., and Alonized Incoloy 800 in Stage II. The molybdenum tube/tungsten-rhenium wire inner sheath combination appears to be holding up well considering the rapid loss of its protective outer tube and no changes in the inner sheath combination are being considered at this time. SiC thermowells have experienced a high failure rate in the State I environment. Based on information contained in published reports and independent failure analysis, it appears that SiC will not withstand the high temperatures, slagging conditions of Stage I and alternate outer well materials must be evaluated. Information in reference indicates that high purity alumina and chromium oxide materials may be capable of withstanding the Stage I environment, and these materials will be tested. In addition to these materials, literature searches and discussions with material vendors indicate that outer wells fabricated from molybdenum, ceramic coated molybdenum, and a molybdenum-zirconium oxide composite, also show promise in the Stage I environment. Future gasifier operations will evaluate all of the above materials in an effort to obtain a satisfactory BI-GAS Stage I outer well.

34343 (ANL—78-7, pp 391-411) **Infrared radiometry applied to critical temperature measurement in the coal gasification process.** Leftwich, R.F. (Barnes Engineering Co., Stamford, CT). 1977.

From Symposium on instrumentation and control for fossil demonstration plants; Chicago, IL, USA (13 Jul 1977).

In Proceedings of the 1977 symposium on instrumentation and process control for fossil demonstration plants.

Two infrared radiometric instruments are described for monitoring the radiant energy inside a coal gasification reactor. One supplies rapid temperature monitoring and the other provides spectral scanning to evaluate the process performance. Both instruments have adequate environmental, speed of response, and sensitivity capabilities. In addition, they have modular flexibility to readily adjust the field of view, wavelength region of operation, and performance characteristics to accommodate necessary changes based on new information about the reactor as it becomes known.

34344 (CONF-770652—) **Proceedings of the third annual underground coal conversion symposium.** (Department of Energy, Washington, D.C. (USA)). 1977. Contract W-7405-ENG-48. 532p. Dep. NTIS, PC A23/MF A01.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

The Third Annual Underground Coal Conversion Symposium was held at Fallen Leaf Lake, CA, June 6—9, 1977. It was sponsored by the U.S. Department of Energy and hosted by Lawrence Livermore Laboratory. Forty-one papers have been entered individually into EDB and ERA; ten papers had been entered previously from other sources. The papers cover the in-situ gasification of lignite, subbituminous coal and bituminous coal, in flat lying seams and a steeply dipping beds, at moderate and at greater depths, and describe various technologies of (borehole linking, well spacings, gasifying agents (air, oxygen, steam, hydrogen, including mixtures). Measuring instruments for diagnostic and process control purposes are described. Environmental impacts (ground subsidence and possible groundwater pollution) are the subject of several papers. Finally, mathematical modelling and projected economics of the process are developed. (LTN)

34345 (CONF-770652—, pp 5-28) **1977 ERDA underground coal conversion program.** Wieber, P.R.; Sikri, A.P. (Energy Research and Development Administration, Washington, DC). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

The status of the 1977 program for underground coal conversion program being conducted by the U.S. Energy Research and Development Administration (ERDA) is reviewed. The program management uses a team concept to maximize the resources of ERDA Headquarters and of the Field facilities. The program participants are listed and the accomplishments during the past year are summarized. An appraisal of the status of the technology is made, listing future priorities which the program will address. It is concluded that low-Btu gas production using the Linked Vertical Well (LVW) concept could be commercialized by 1985, steam/oxygen technology will be developed using the LVW concept, and directional drilling and hydraulic fracturing are the most promising methods to link and gasify the process wells in Eastern coals.

34346 (CONF-770652—, pp 53-65) **Status report on MERC's program for in situ gasification of bituminous coals.** Strickland, L.D. (Morgantown Energy Research Center, WV). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

Since early 1973, MERC has pursued an In Situ Coal Gasification program designed to develop a process for gasifying the relatively deep, thin, eastern bituminous coal seams. Major emphasis in the past was placed on modeling and laboratory testing required for defining basic properties and understanding the In Situ process. During recent months, critical program reviews have been initiated and the major emphasis has been shifted to a field program. Initial field tests are designed to utilize information produced by the successful LERC tests at Hanna. This increased emphasis on field testing should result in an accelerated evaluation of the technology for eastern coals. Major program thrusts resulting from this shift of emphasis, recent program achievements and future plans are reported.

34347 (CONF-770652—, pp 66-76) **Review of LERC's in situ coal gasification project.** Brandenburg, C.F.; Fischer, D.D.; Boyd, R.M.; King, S.B.; Humphrey, A.E. (Laramie Energy Research Center, WY). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

Although no field tests have been conducted by the Laramie Energy Research Center (LERC) since the Second Annual Underground Coal Gasification Symposium, additional analyses of data from the Hanna II test have been completed. These analyses consist of energy balances, thermal efficiencies, and process efficiencies for

all phases of Hanna II. In addition, preparation for the Hanna III and IV tests is in progress and preliminary planning for Hanna V has been completed. Simulation of in situ coal gasification on a laboratory scale is also being pursued. This paper will discuss the additional analyses of the Hanna II test, describe the Hanna III, IV and V tests, and outline the objectives of the laboratory simulation experiments.

34348 (CONF-770652—, pp 77-78) **Sandia Laboratories project review: instrumentation and process control development for in situ coal gasification.** Northrop, D.A. (Sandia Labs., Albuquerque, NM). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

Sandia Laboratories has been developing and evaluating instrumentation for in situ coal gasification in conjunction with the series of experiments conducted at Hanna, WY, by the Laramie Energy Research Center. Two broad classes of instrumentation are under development: (1) diagnostic techniques to provide detailed in situ information to aid in process characterization and understanding, and (2) remote monitoring techniques to provide commercially practical means of obtaining a real-time map of the dynamic process for use in process control. Further development of the techniques will be pursued in conjunction with LERC's Hanna IV experiment which is in the construction phase and is scheduled for ignition in 1977. Two additional objectives include: (1) the development of a minicomouter-based data acquisition system to provide real-time, on-site reduction, analysis and display capabilities for all the instrumentation techniques, and (2) the development of a diagnostic well specification for in situ geo-energy applications which will cover the hardware, fielding, data acquisition, and analysis aspects for the thermal and in-seam gas sampling and pressure instrumentation.

34349 (CONF-770652—, pp 81-82) **1977 progress report for the Texas Utilities UCG program.** Clements, B.R. (Texas Utilities Generating Co., Dallas). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

In March, 1975, Texas Utilities Company signed a license agreement with Licensintorg of the U.S.S.R. for technical documentation and assistance in underground coal gasification. A hydrological and geological study of the coal seams near Texas Utilities' Big Brown Steam Electric Station in Freestone County, Texas was conducted for the purpose of construction of a Pilot Plant in this area. However, due to the amount of ground water in the area, a "technological test site" was established to prove that ignition and gasification in this area was possible. In September, 1976, the test was classified as a success and gasification was stopped. However, a decision was made to move the possible Pilot Plant site to Anderson county, Texas. The site is approximately 10 miles from the original Big Brown site. Hydrological and geological tests are presently being conducted to evaluate this site. Once this site is proven, a Pilot Plant will be constructed. If the economic, environmental and technical aspects of the site prove favorable, Texas Utilities will consider the installation of a commercial plant at this site.

34350 (CONF-770652—, pp 83-91) **Texas A and M project status: underground lignite gasification.** Jennings, J.W.; Strickland, R.F.; Von Gonten, W.D. (Texas A and M Univ., College Station). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

During the past three years laboratory studies have been conducted on Texas lignite to determine combustion and gasification products as a function of pressure and temperature. More recently, the scope of the program has been expanded to include mathematical modeling and field testing. A numerical model has been developed which predicts gas composition and flame front velocity. The model has been validated by simulation of laboratory combustion tube experiments on Texas lignite. The model and laboratory experiments were used to design a field test on underground lignite gasification in the Yegua formation in Brazos County, Texas. In addition, the model has been used to make parametric studies.

34351 (CONF-770652—, pp 92-103) **Underground coal gasification in Canada.** Roehl, A.A.; Brown, R.A.S.; Jensen, E.J. (Alberta Research Council, Edmonton). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

During the summer and early fall of 1976, the Alberta Research Council sponsored by four government agencies and eleven private companies, carried out a field test of underground coal gasification in Alberta. The test took place at Forestburg, Alberta, located approximately 120 miles southeast of Edmonton, in a 12-foot seam of subbituminous coal under 65 feet overburden. Test plan for the project involved successively linking and gasifying the two shorter sides of a 30 x 60-foot rectangular test pattern. Approximately 300 tons of coal were affected during the test.

34352 (CONF-770652—, pp 104-106) **Steeply dipping seam project status.** Hagen, A.A. (Energy Research and Development Administration, Lakewood, CO). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

ERDA has initiated a request for proposals for the Underground Gasification of Steeply Dipping Coal Beds (RFP-EF-77-R-03-1472). This procurement action is expected to result in a project consisting of four phases: a feasibility study and program plan preparation phase, a site evaluation and experimental design phase, a field experiment and analysis phase and a pilot scale design phase. It is expected that this project will be cost shared by industry. The objectives of the project are to develop the technology, to verify the technical and preliminary economic feasibility and to provide a preliminary design and cost estimates for a pilot scale project. Award of a contract to industry is expected by the end of the current fiscal year.

34353 (CONF-770652—, pp 107-118) **Economic prospects of underground gasification at great depth and under high pressure.** Patigny, J. (Univ., Louvain, Belgium); Chandelle, V. 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

At first the authors recall the reasons which cause several European countries to become interested in the methods of gasification at great depth and at high pressure. They propose a general scheme and underline the interest of applying a cyclic variation of the pressure. After pointing out the economical results of the use of a dry and tight gas generator (decrease of leakages and increase of the heating value of the gas), the authors show up the various gains which high pressure can bring about on the economic level. Three points are underlined: Compensation of the increase of the cost of boreholes with the depth through a small increase of their spacing; reduction of the energy consumed for the production and the circulation of the gasifying agent; and increase of the amount of energy generated from each m^3 of gasified coal.

34354 (CONF-770652—, pp 119-123) **In situ gasification of coal in Germany within the energy R and D program of the federal government: incentive, concept, program, and projects.** Neumann, R. (Kernforschungsanlage, Juelich, Ger.). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

It is concluded that in situ gasification of coal should not be developed generally in Germany; rather the development showed depend on a definite concept put forward by WENZEL and coworders. This concept is characterized by: Gasification under pressure and pressure change (20—60 bar); testing of gasification using various gasification media including H_2; gasification at depths greater than 800 m; and obtaining gasification as far as possible by means of filtration gasification. Gasification under pressure promises to produce some advantages in reaction kinetics and higher conversion rates of carbon and is essential for hydro-gasification. The addition of Ht^2 as gasification medium, theoretically leads to the possibility of producing an intermediate gas with an energy content of over 3.000 kcal/m. Only at a depth of 800 m and below is the application of pressure and pressure change feasible because of the reduced natural permeability of the overburden. The technical realization of the filtration method could have a decisive significance on the economics of in situ coal gasification. From the above mentioned special concept, whose characteristic points have not yet been investigated expeimentally anywhere, a limited program has been drawn up. Where investigations are not going to be carried out in the German program, we will rely on the results from documented and current projects particularly in the U. K., in Belgium and the USA. A German-Belgian collaborative agreement has been signed bilaterally in 1976, in order to guarantee, above all else, the exchange of experience and knowledge and ensure that the projects being undertaken in Germany and Belgium which are based on similar concepts are complementary. The overall objective of the German research and development program is to determine whether in situ gasification can technically and economically be carried out in German hard coal.

34355 (CONF-770652—, pp 124-125) **Program and status of the investigations in in situ coal gasifications at RWTH, Aachen.** Beckervordersandforth, C.P.; Wenzel, W.; Franke, F.H.; Gudenau, H.W. 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

The aim of the researh at RWTH Aachen is the experimental and theoretical evaluation of Underground Gasification Technology for use in the Federal Republic with the main points: Investigations in preparation for a field experiment in the Saarland; in particular, gasification behavior of Saar coal towards different gasification agents, for example towards hydrogen, and realization of flow experiments on coals and stones of the Saarkarbon; investigation of gasification under pressure and pressure-change conditions; general considerations on the preparation of field experiments; and formation of a model for the estimation of the different factors influenceing underground gasification process, as for example pressure, temperature, speed, duration and concentration of the gasification agent. A feasibility study will be developed on the basis of the theoretical and experimental investigations conducted. The advantages of pressure change have been mentioned by Belov: Removal of the ash layer covering the reaction zone; increasing heat and mass transport by convection; to avoid blocking of gas channels; and to avoid dead space for gasification. The gasification agents to be studied are: Air/steam, oxygen/steam and hydrogen.

34356 (CONF-770652—, pp 129-136) **Prediction of product composition and sweep efficiency in underground coal gasification.** Edgar, T.F.; Dinsmoor, B.; Johnson, C.M. (Univ. of Texas, Austin). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

The prediction of product gas composition and sweep efficiency for underground coal gasification are extremely important in the economic design and operation of these facilities. While the integration of nonlinear partial differential equations may be required for obtaining both of these quantities, it appears that the product gas composition is predictable by algebraic methods, involving a total energy balance and some data on chemical equilibrium. Simple models may also be useful for predicting sweep efficiencies, but channel growth appears to be much too complicated to obtain without a reasonably detailed set of differential equations. Simulations and sensitivity studies on channel growth are reported in this paper.

34357 (CONF-770652—, pp 146-159) **Linear stability of reverse combustion for in situ coal gasification.** Krantz, W.B. (Univ. of Colorado, Boulder); Gunn, R.D. 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

A linear stability analysis of reverse combustion in coal has shown that the process is only conditionally stable. The reverse combustion linking process is unstable for the subbituminous coal properties of the Hanna No. 1 seam and for the operating conditions utilized during the Laramie Energy Research Center's in situ coal gasification field tests conducted at Hanna, Wyoming. With the aid of several simplifying assumptions, a universal neutral stability curve is obtained; that is, the locus of the dimensionless neutrally stable wavelengths (combustion finger diameters) is a unique function of a single dimensionless parameter involving heat removal from the combustion front and heat generated at the front. The curve describing the most highly amplified wavelength provides an estimate of the diameter of the combustion fingers, 2.9 feet, which is in good agreement with estimates based on thermal field test data. The analysis also provides insight into how high pressure air requirements can be scaled for the reverse combustion linking process for different well spacing.

34358 (CONF-770652—, pp 168-177) **Future directions for combustion modeling of underground coal conversion.** Corlett, R.C.; Carson, P.T. (Univ. of Washington, Seattle). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

Some unresolved combustion modeling problems are identified as important for underground coal conversion, and research approaches are suggested. Permeation rather than borehole reactor concepts are emphasized. But combustion in small channels appears to be an essential feature of both combustion linkage and gas production phenomena. Solid-phase heat conduction is of fundamental importance in reverse combustion along fissures. Tentatively identified regimes are characterized by a low air velocity fuel-lean wave with downstream oxygen burnout, a higher velocity boundary layer flame, and at still higher velocity char oxidation at the surface. During production, a growing exploited volume is bounded by a fire face which varies from fully permeative (mean gas flux vector normal to face) to non-permeative (flux vector parallel to face). Rubblization at non-permeative faces, and flow restriction along linkage channels and permeative fire face fissures generally are essential for sustained production and good resource utilization. Likely slow-restriction mechanisms are ash-clogging and condensation ahead of forward propagating flames. Fire face rubblization depends crucially on inward migration of hot gases along fissures. Prediction of such rubblization requires quantitative description of coupling between inflow of hot gases and thermally induced coal shrinkage.

34359 (CONF-770652—, pp 178-187) **One-dimensional underground coal gasification model including heat transfer and water intrusion.** Schwartz, S.H.; Butler, H.W.; Morris, T.; Lutz, S. (West Virginia Univ., Morgantown). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

A one-dimensional model of the in-situ underground coal gasification process was developed which essentially extends previous work in this area to include the effects of heat losses to the surroundings and water intrusion into the reaction zone. There are several techniques available for calculating the heat losses to the overburden and underburden and the one used here is an easily applied approximation. The water intrusion equations represent a highly simplified version of the actual process. Modification of the heat transfer and water intrusion equations is anticipated and will be documented in the final report of ERDA Contract No. E(40-1)-5081. The model has been programmed for computer solution. Preliminary calculations of the product gas composition and temperature distribution are presented.

34360 (CONF-770652—, pp 211-218) **Oxidation kinetics of Texas lignite.** Hsia, S.J.; Edgar, T.F. (Univ. of Texas, Austin). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

The oxidation of coal during underground coal gasification affects both the product gas composition and the sweep efficiency of the process. The kinetics of coal and carbon oxidation has been studied by many investigators, and the lack of agreement in the results continues to confuse the issue. Kinetics experiments to determine the race of oxidation of Texas lignite char are described in this paper. The most difficult experimental problem encountered is the maintenance of an isothermal condition.

34361 (CONF-770652—, pp 219-228) **Preliminary analysis of data from MERC Simulation Laboratory.** Martin, J.W. (Morgantown Energy Research Center, WV). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

The Morgantown Energy Research Center is conducting a project designed to develop a process to recover relatively deep, thin-seam, eastern U.S. bituminous coals in situ. One phase of the program involves laboratory testing to investigate the basic properties of bituminous coals and to simulate various gasification concepts prior to field testing. Nineteen tests have been conducted to date and a six-month study to analyze and interpret the data has been initiated. The laboratory facility is reviewed and a summary of the nineteen tests is presented. Post-test examinations of samples are interpreted to identify many of the phenomena associated with the combustion and gasification of bituminous coal.

34362 (CONF-770652—, pp 322-334) **Remote electromagnetic sensing of underground coal burns.** Quincy, E.A.; Rhoades, M.L.; Sturm, K.A. (Univ. of Wyoming, Laramie). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

The principal objective of this research project is to develop and field test an induction system and estimator algorithm for remote determination (at the surface) of the location, shape and size of underground coal burns. Field measurements were conducted with a wideband loop-loop induction system at the Hanna Underground Coal Gasification Site of the LERC during July, August and October 1976. Soundings were made on five traverses at two different locations. Field data were processed on a Fourier Analyzer System and 3-dimensional response maps were plotted via the central computing system in both time and frequency domains. Strong anomalies at 5 kHz were observed on traverses over both burns at Hanna II. Induction soundings at 5 kHz (corresponding to a depth of penetra-

tion comparable to the coal burn depth) taken at Hanna II, Phase 1 indicate that the burn may have protruded 5m farther to the West than originally estimated by the LERC. Induction soundings at the Hanna II, Phase 2 and 3 show that the low frequency response acquired a second peak with aging. However, the high frequency response changed dramatically, probably due to removal of the horizontal pipes interconnecting the wells. These results would support the conclusion that there is a possibility of monitoring the burn front. Delineation of the burn is not dependent on the cavity filling with saline ground water, but invasion of the burn region by ground water may possibly be detected.

34363 (CONF-770652—, pp 345-350) **Economics of underground coal gasification in British conditions.** Mann, J.R. (National Coal Board, Harrow, Eng.). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

In the coming years Britain may enjoy a period of self-sufficiency in energy, based on oil and gas from the North Sea and increased production of coal. However, by the turn of the century, indigenous energy production may again fall short of demand. The shortage could be satisfied by imported fuels, as is the case now, but it is unwise to assume that unlimited supplies would be available. This, and the detrimental effects of imports on the balance of payments, could lead to greater exploitation of indigenous energy sources, in particular our abundant reserves of coal. These reserves would be used in the conventional ways or as a feedstock in the production of synthetic fuels. For some of these purposes a gas, such as that produced by the underground gasification of coal, may be a more attractive feedstock than solid coal and this could be so in the manufacture of synthetic natural gas.

34364 (CONF-770652—, pp 351-360) **Economic aspects of thin seam underground coal gasification.** Hahn, O.J.; Debrand, S. (Inst. for Mining and Minerals Research, Lexington, KY). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

An underground coal gasification system is described which combines the advantages of today's auger mining techniques with underground coal gasification. The cost estimate has been made for an auger mine combined with an underground gasification system. The coal cost with a 15 percent DCF rate is $8.73 for a production of 1.08 million tons. The gas cost for gasification after auger mining has been estimated at $0.23 per MM Btu for an output of 7×10^{12} Btu per year.

34365 (CONF-770652—, pp 361-366) **Low Btu gas produced by UCG in the western U.S.: economics and prospects.** Moll, A.J.; Alich, J.A.; Dickenson, R.L. (SRI International, Menlo Park, CA). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

Underground coal gasification (UCG) to produce low Btu gas (LBG) has been tested successfully on numerous coal seams in several countries. Further tests will be useful in improving the technology and examining environmental effects. However what is most needed now is commercial demonstration of LBG production by UCG on a large scale. In this paper the economics and marketplace competitiveness of UCG are examined. The economics of LBG production are attractive based on conservative assumptions drawn from the Hanna test results. The required price for LBG produced by underground gasification of western subbituminous coal is estimated to be about $1.30 per million Btu. The principal unproved assumption in arriving at this price is that the Hanna results can be extended economically to gasification across a large array of wells. The most important use of LBG produced in sparsely populated western coal fields is the generation of electric power. Base-load electric power produced by firing strip-mined coal in the west is estimated to cost about 26 mills per kWh at the mine mouth. This is slightly more than the price of power from firing LBG produced by UCG. For much of the west both these prices are lower than prices required for nuclear power or oil-fired produced power. The key to the competitiveness of "mine-mouth" conventional or UCG-based power plants is the cost of power transmission. The cost of power transmission is dependent upon high capacity. For example, a typical cost of transmitting 5,000 megawatts of power is about 1 mill per 100 miles, but the cost of transmitting 500 megawatts is about 5 mills per 100 miles. These costs suggest that "in-situ power" generated in Wyoming may someday be competitive as far away as southern California.

34366 (CONF-770652—, pp 367-375) **UCG cost predictions based on field performance.** Garon, A.M.; Swartz, G.B. (Gulf Research and Development Co., Pittsburgh). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

The costs of gaseous products from underground coal gasification (UCG) are predicted based on the results of field and laboratory tests and numerical modeling. The process data from the Hanna experiments and from the Russian experience are used along with reasonable assumptions for the operational parameters, and the seam data are based on Western U.S. coal geology. The costs are compared to each other, to those obtained assuming Lurgi process data would be obtained from a commercial underground gasifier, and to the cost of SNG produced by surface gasification of mined coal. In addition, the effects of several parameters on the product costs are shown for assumed parametric interrelationships. The cost predictions were obtained using a previously developed computer code which includes all of the components of a hypothetical commercial UCG plant. The capital requirements and operational expenses were obtained from Gulf experience and a variety of other sources and updated to the current time base. Sales prices were determined for three different product gas options: SNG and a medium-heating-value gas obtained with oxygen injection and a low-heating-value gas obtained with air injection.

34367 (CONF-770652—, pp 376-392) **Economic comparison of the in situ gasification of horizontal and steeply dipping coalbeds.** Buder, M.K.; Terichow, O.N. (Bechtel Corp., San Francisco). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

A significant fraction of domestic coal resources occur in deep-lying or steeply inclined seams which are for various reasons uneconomical to mine. Underground coal gasification (UCG) appears to be a promising method to recover the energy stored in these unmineable reserves. Virtually all of the developmental effort expended on UCG in the United States has been concentrated on the in situ gasification of horizontal coalbeds. The existence of significant domestic coal reserves in the form of steeply dipping beds (SDB's) and the successful in situ gasification of SDB's on a commercial scale in the Soviet Union justify an effort toward the development of SDB gasification techniques in this country. Furthermore, SDE gasification may be economically advantageous compared to the UCG of horizontal seams in certain cases. Two conceptual economic case studies for the UCG of western coal are presented here. The first examines the cost of raw low-Btu gas from the UCG of a flat horizontal coalbed using the Linked Vertical Well (LVW) technique. The latest data from the Hanna II tests (Phases II and III) are used as the basis for LVW economics. In the second case study, Soviet experience provides some basis for the development of raw gas costs for SDB gasification.

34368 (CONF-770652—, pp 393-396) **What the chemical industry needs from in situ coal gasification.** McGeorge, A. Jr.; Quinn, R.S. (E.I. du Pont de Nemours and Co., Wilmington, DE). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

The U.S. Chemical Industry looks to coal gasification, whether in-situ or in above-ground gasification plants, to provide in the long run much of its requirements for both synthesis gas and fuel gas. The chemical industry needs H_2/CO mixtures as synthesis gases for production of many chemicals, but primarily for the production of ammonia and methanol. In these uses the H_2/CO mixture should be reasonably free of diluents such as nitrogen or methane. The chemical industry uses gaseous fuel for generating process heat and process steam. The use of gaseous fuel results in lower costs compared to solid fuels and heavy petroleum because of lower investment for combustion equipment and reduced operating costs. To be effective in existing boilers and process furnaces, the gas must have medium (300 BTU/scf) to high (1000 BTU/scf) fuel content. The chemical industry does not want to relocate its plants to mine-mouth western coal locations and thus in-situ coal gasification, to be competitive with above-ground gasification processes must be applicable to coals located near areas of chemical industry concentration. The chemical industry needs to be able to evaluate the technical and economic feasibility of in-situ coal gasification processes for a specific site. To do this, the process must produce a gas with reliably controlled composition and volume. Also, sufficient in-depth understanding of the geological, chemical, combustion, and environmental factors must be achieved to allow a reasonable assessment of the process feasibility and economics for a potential site based on limited test drillings and laboratory analysis.

34369 (CONF-770652—, pp 399-411) **Steeply dipping coal beds suitable for in situ gasification: a resource assessment.** Choate, R.; Lent, J. (TRW Systems and Energy, Redondo Beach, CA). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

Steeply dipping coal beds potentially suitable for underground gasification are defined in this study to be at least 3 feet thick, dipping at angles greater than 35 degrees. Such beds occur in the United States in four major coal provinces: Appalachian, Rocky Mountain, Pacific Coast and Alaska. The total U.S. resource is estimated at 100 billion tons, 70 billion of which is in seven western States: Colorado, Washington, New Mexico, Wyoming, Montana, Utah, and California. Coal fields of interest are described for these States, where steeply dipping beds are located mainly along margins of large structural basins, on monoclinal folds, and on limbs of anticlinal-synclinal folds, in more than 40 fields and areas.

34370 (CONF-770652—, pp 412-421) **Assessment of geological factors for underground coal gasification of steeply dipping beds.** McCurdy, R. 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

The objective of this paper is to investigate the possible effect that geological factors will have on the in situ gasification of steeply dipping coal beds. Four key operating stages of underground coal gasification of steeply dipping beds are reviewed for the purpose of correlating the effect of geological factors to operating problems. Eighteen specific geological considerations of the coal bed and seven specific geological considerations external to the coal bed are identified and their possible effect on the operating stages are discussed.

34371 (CONF-770652—, pp 422-429) **Subsidence and roof response studies related to underground coal gasification.** Advani, S.H.; Lin, Y.T. (West Virginia Univ., Morgantown). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

State-of-the-art literature on subsidence resulting from conventional mining and underground coal gasification is briefly reviewed and results from various empirical and phenomenological trough models are detailed. Displacement and stress profiles, pertinent to UCG experiments, obtained from finite element modeling techniques are presented. Roof failure and crack propagation criteria are described. In addition, the roles of thermal stresses and subsequent block caving are also discusseed with reference to water influx and gas leakage.

34372 (CONF-770652—, pp 430-434) **Approach to subsidence problems of underground coal gasification.** Forrester, D.J. (National Coal Board, Coleorton, Eng.). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

The paper examines the problem of subsidence from underground coal gasifiers. Note is made of the subsidence engineering expertise acquired by the National Coal Board relating to subsidence caused by the mechanised longwall mining of coal in the U.K. The suitability of this expertise to application in the gasification situation is reviewed and a favorable result concluded. Finally notes are included indicating possible approaches to the solution of some of the potential problems of subsidence due to gasifiers.

34373 (CONF-770652—, pp 435-447) **Ground subsidence resulting from underground gasification of coal.** Gregg, D.W. (Univ. of California, Livermore). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

Ground subsidence is a very significant phenomenon that must be dealt with in the design and operation of an underground coal gasification process. This paper deals with the types of subsidence and their effect on the process. The various types of subsidence are briefly discussed, and the experiences the Soviets had while operating their commercial underground gasification stations are reviewed.

34374 (CONF-770652—, pp 448-453) **Hydrologic aspects of underground coal gasification.** Brimhall, R.M. (Resource Sciences Corp., Tulsa, OK). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

Socially, economically, and technically successful gasification of coal by in-situ methods requires the integration of many dynamic systems each of which is an important link in the technological chain required to produce a quality product at minimal dollar, social, and environmental cost. Fundamental to this concept is understanding the three-dimensional distribution of mechanical energy in the water (groundwater potentials) and hydraulic conductivities which together will control the resultant direction of groundwater movement before, during, and after gasification. Groundwater potentials and hydraulic conductivities will both be influenced by the fundamental geological control of each site selected for experimental and commercial in situ gasification projects. On a site-specific basis, and under specific conditions of operation, it may become necessary to divert groundwater flow away from gasifiers by another link in the chain—a groundwater control system. The use of horizontal boreholes may allow such systems of groundwater control to be more economic than the vertical well system for diverting water away from underground gasifiers.

34375 (CONF-770652—, pp 454-465) **Permeability characteristics of coal seams.** Lien, C.L.; Reznik, A.A.; Fulton, P.F.; Wilson, B.A. (Univ. of Pittsburgh). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

Values of absolute permeability to gas and porosity for Pittsburgh, Hanna, and Gillette coals are presented. Effective and relative permeabilities to gas as functions of water saturation and flow orientation are also calculated from steady-state Darcian flow experiments. The rate of increase in permeability to gas past the critical gas saturation is significantly greater as the rank of the coal decreases. Similarly values of absolute permeability, shrinkage, and porosity are inverse functions of rank. Values of the former range over three orders of magnitude. The critical gas saturation does not appear to be a function of rank.

34376 (CONF-770652—, pp 469-475) **Hydrologic characterization for Hanna III.** Hutchinson, H.L. (Univ. of Wyoming, Laramie); Boyd, R.M.; Fischer, D.D. 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

While the technical feasibility of UCG has been studied, the environmental impacts have not. The Hanna III test is designed to study two of these impacts: subsidence and effects on groundwater quality. The water quality analyses, both pre- and post-burn, are described, as are the hydrological tests of both the seam and the one overlying aquifer. Results to date indicate that both the seam and aquifer possess both low and directional flow properties.

34377 (CONF-770652—, pp 490-499) **Hydrology and water monitoring at Texas Utilities site near Fairfield, Texas.** Itz, D.D.; Oliver, R.W. (Texas Utilities Fuel Co., Dallas). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

Before starting any field testing of the in-situ gasification process, Texas Utilities Company did extensive investigations concerning the geologic and hydrologic characteristics of the site chosen. The presence of ground water in several strata surrounding the lignite beds and the lateral and vertical variability in the water-bearing characteristics of these strata present potential problems from both the technical and the environmental points of view. After this detailed evaluation of the site was completed and several ground water monitoring wells were installed, in-situ gasification was carried out using three production wells. Water quality was monitored in the surrounding area during gasification and in both the gassed out space and the surrounding area after gasification. The results of the program indicate that using the Texas Utilities-Soviet process, contamination does not travel for any significant distance outside the gassed out space either during or after gasification. Furthermore, the contaminated water left in the gassed out space after the process is complete tends to naturally return to baseline values with time. Continued monitoring will be done at the Texas utilities site to varify these preliminary findings.

34378 (CONF-770652—, pp 500-507) **Groundwater pollutants from underground coal gasification and their fate.** Humenick, M.J.; Mattox, C.F. (Univ. of Texas, Austin). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

The purpose of this study was to determine the contaminants released to groundwaters as a result of the underground gasification of lignite and to determine the ability of the surrounding strata to moderate their impact. Groundwater pollutants principally arise from ash leachate and condensed vapors in surrounding strata. Ash

was found to yield sulfate, calcium, and hydroxide while condensed vapors contributed organics and ammonia as major changes to water quality. The organics consisted of mostly polynuclear aromatic hydrocarbons. Phenols were not major organic components. Lignite and clay strata were studied to determine their ability to sorb the groundwater contaminants. Both types of strata were effective in sorbing organics and ammonia. The behavior could be described by Freundlich isotherms. Divalent cations were released by ion exchange with monovalent cations. Anions had little affinity for the strata. Relatively little migration of ammonia and most of the organics was predicted as compared with calcium, sulfate, and some nonsorbable organics.

34379 (CONF-770652—, pp 508-511) **Purification of gas from an in-situ coal gasification process.** Phillips, W.R. (Radian Corp., Austin, TX). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

Untreated in-situ coal gas is a corrosive, erosive energy source which probably cannot be pipelined long distances economically because of its low caloric value (about 170 Btu per cu ft, NHV). One alternative being examined is on-site power generation using combined cycle units. However, the raw gas must first be purified before entering the combined cycle unit. Removal of particulates and corrosive vapors such as H_2S and alkali metals is necessary to protect the gas turbine, especially the high-speed blades. A small pilot unit designed to purify gas for a 300 scfm turbine (approximately 0.4 MWe) would cost about $0.96 million +- 30%. This scale is believed to be appropriate for initial purification train development. Fixed capital for gas purification and supporting offsites was estimated at $9.4 million for 25 MWe capacity, not including turbogenerator. This cost was obtained by scaling up the costs for the 300 scfm unit. This capital is equivalent to a cost of 3.3 mills per KWh if the plant generates power for 20 years at 65% capacity. The most difficult development task will probably be to attain satisfactory removal of tar aerosol and alkali metal compounds from the high temperature wellhead gas.

34380 (CONF-770652—, pp 512-516) **In-situ gasification: what it looks like from sitting on top.** Shell, A.L.; France, T.M. (Powder River Basin Resource Council, Sheridan, WY). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

The Powder River Basin Resource Council, a citizens' group working to preserve the agricultural communities in the face of industrial development, anticipates problems with "in-situ" coal gasification in regards to ground water, subsidence, air quality, and social impacts. However, if technology can solve the problems of ground water contamination and subsidence in connection with "in-situ" gasification, then the process offers advantages over conventional coal mining and above-ground gasification plants. The Council recommends the piping of the gas to areas of need instead of building on-site electrical generating plants, so as to curb the impact problems. The Council also urges the development of the process if it is offered as a partial alternative to the present coal industry. If the process is offered only as an additional fuel source, then the added environmental and social impacts from its development will only create more problems instead of alleviating them.

34381 (COO—0003-20) **Synthane Pilot Plant, Bruceton, Pa. Run report No. 1. Operating period: July—December 1976.** (Combustion Engineering - Lummus, Bloomfield, N.J. (USA)). 1976. Contract EY-76-C-02-0003. 438p. NTIS, MF A01.

Portions of document are illegible.

Test Directive No. 1 provided the operating conditions and process requirements for the first coal to be gasified in the Synthane Pilot Plant. Rosebud coal, which is a western sub-bituminous coal, was chosen by DOE because of its non-caking properties and reactivity. This report summarizes and presents the data obtained. The pilot plant produced gas for a total of 228 hours and gasified 709 tons of Rosebud coal from July 7 to December 20, 1976. Most of this period was spent in achieving process reliability and learning how to operate and control the gasifier. A significant number of equipment and process changes were required to achieve successful operation of the coal grinding and handling facilities, the Petrocarb feed system, and the char handling facilities. A complete revision of all gasifier instrumentation was necessary to achieve good control. Twenty-one test runs were accomplished, the longest of which was 37 hours. During this run, carbon conversions of 57 to 60% were achieved at bed temperatures of 1450 to 1475°F. Earlier attempts to operate the gasifier with bed temperatures of 1550 and 1650°F resulted in clinker formation in the gasifier and the inability to remove char. Test Directive No. 1 was discontinued in January 1977, without meeting the directive's goals because the process conditions of free fall of coal feed into the Synthane gasifier resulted in excessive quantities of tar and fines carryover into the gas scrubbing area. Each time the gasifier was opened after a run, the internal cyclone dip leg was found to be plugged solidly with hard tar and fines. The gas scrubbing equipment was always badly fouled with char and tar requiring an extensive and difficult cleanout. Packing in the gas scrubber had to be completely changed twice due to extensive fouling.

34382 (FE—1513-66) **Agglomerating Burner Gasification Process. Design, installation, and operation of a 25-ton-a-day Process Development Unit. Quarterly report, July—September 1977.** Adams, R.R.; Corder, W.C. (Battelle Columbus Labs., Ohio (USA)). Dec 1977. Contract EX-76-C-01-1513. 29p. Dep. NTIS, PC A03/MF A01.

Attempts to achieve gasification continue to be hampered by mechanical difficulties. Further modifications in the design of the solids circulation loops appear to have been effective in reducing erosion in the bottom sections. Stainless steel liners, installed as a temporary expedient in the burner and gasifier, have reduced circulation blockage by refractory spalls. Although five operating campaigns made during the quarter failed to produce significant quantities of make gas, progress toward the objective was achieved during each run, and valuable data were obtained. The commercial concept report has been completed and is currently being reviewed. The erosion test rig is complete and awaiting hot calibration and installation. Work was initiated and progressed on the production of a design manual for the PDU.

34383 (FE—2247-11) **Gasification of residual materials from coal liquefaction. Quarterly report, July—September 1977.** Robin, A.M. (Texaco, Inc., Montebello, Calif. (USA). Montebello Research Lab.). Oct 1977. Contract EX-76-C-01-2247. 15p. Dep. NTIS, PC A02/MF A01.

A total of seven type I Laboratory Evaluations and one type II Preliminary Pilot Plant Evaluation have been completed to date. A final report on the type II Preliminary Pilot Plant Evaluation of 20 bbls of H-Coal Syncrude Vacuum Tower Bottoms was completed and submitted to ERDA for approval. Pertinent results are summarized. Two 5-gallon samples were received: The first is a sample of vacuum flash drum bottoms from the SRC II coal liquefaction pilot plant in Tacoma, Washington, and the second is a sample of vacuum tower bottoms from the Exxon Donor Solvent coal liquefaction process. Type I Laboratory Evaluations have been completed and reports have been written. The expected yields and operating conditions based on the laboratory evaluation of the SRC II vacuum drum bottoms are summarized. The sample, which was obtained from the liquefaction of Kentucky No. 9 and 14 coal, was judged to be a suitable feedstock for the Texaco Coal Gasification Process. It may be charged directly to a Texaco gasifier as a molten fluid at 700°F. The material is too viscous to be pumped with the pilot plant equipment available, however. If pilot plant tests are desired, a suitable cutter stock must be added to reduce the viscosity to an acceptable level. The expected yields and operating conditions based on the laboratory evaluation of the Exxon vacuum tower bottoms are summarized. The sample, which was obtained from the liquefaction of Illinois No. 6 coal, was judged to be a suitable feedstock for the Texaco Coal Gasification Process. It may be charged directly to a Texaco gasifier as a molten fluid at 700°F. The material is too viscous to be pumped with the pilot plant equipment available, and, therefore, will require the addition of a cutter to reduce its viscosity.

34384 (FE—2247-12) **Gasification of residual materials from coal liquefaction. Evaluation of SRC ash concentrate from Kerr—McGee Corp. as feedstock to the Texaco Coal Gasification Process.** Robin, A.M. (Texaco, Inc., Montebello, Calif. (USA). Montebello Research Lab.). Dec 1977. Contract EX-76-C-01-2247. 11p. Dep. NTIS, PC A02/MF A01.

A laboratory evaluation of a 12-pound sample of ash concentrate derived from the SRC process with a solvent deashing operation was completed. The material cannot be melted and, therefore, must be charged to a Texaco gasifier as a water slurry. A 55 percent (wt.) slurry was judged to be pumpable. Operating conditions and yields were estimated for gasifying 1000 pounds per hour of residue at 350 psig. Because of its high ash content (approximately 41 wt. pct.) only about 15 standard cubic feet of hydrogen plus carbon monoxide would be produced per pound of residue gasified. It may be possible to increase the slurry concentration if a residue with a coarser particle size distribution can be obtained.

34385 (FE—2414-5) **Remote electromagnetic sensing of underground coal burns. Quarterly Technical progress report, June—August 1977.** Quincy, E.A. (Wyoming Univ., Laramie (USA). Dept. of Electrical Engineering). Sep 1977. Contract EX-76-S-01-2414. 10p. Dep. NTIS, PC A02/MF A01.

The main objective of this research project is to develop and field test an induction system and estimator algorithm for remote determination (at the surface) of the location, shape and size of underground coal burn regions. Four traverses were run at the Hanna II, Phases 2 and 3 Site to completely characterize it. Strong

anomalies were observed on each traverse. The effect of horizontal pipes interconnecting wells was explored by simulating with and without conducting wire between wells.

34386 (SAN—1429-16) **Molten Salt Coal Gasification Process Development Unit. Quarterly technical progress report No. 4, January—March 1977.** (Atomics International Div., Canoga Park, Calif. (USA)). 20 Apr 1977. Contract EF-77-C-03-1429. 27p. Dep. NTIS, PC A03/MF A01.

The Molten Salt Coal Gasification Process Development Unit (PDU) is being designed to convert one ton per hour of coal into a low-Btu fuel gas at about 180°F and 20 atm pressure. The principal activities during the report period were detailed engineering design and procurement. A complete bid package was prepared covering the first construction subcontract (primarily site preparation, grading, foundations, and underground electrical) and this subcontract was awarded in March 1977. A bid package was also completed for the second subcontract (structural work), and contract award is scheduled for April. Engineering for the third subcontract (balance of plant construction) is scheduled for completion during the next report period.

34387 (SAND—78-8209) **Formation of protective layers on alloys developed for use in coal gasification environments. Quarterly progress report, July 1, 1977—September 30, 1977.** Bradshaw, R.W.; Stoltz, R.E.; Adolphson, D.R. (Sandia Labs., Albuquerque, N.Mex. (USA); Sandia Labs., Livermore, Calif. (USA)). Mar 1978. Contract EY-76-C-04-0789. 37p. Dep. NTIS, PC A03/MF A01.

Progress in attempts at modifying high temperature alloys (stainless steel-310 or Ni-Cr alloys) by adding minor alloying elements to form protective sulfide or improved oxide surface layers is reported. Some success has been found by the addition of titanium to these alloys. Examination by electron microprobe analysis and optical microscopy showed the pressure of titanum in the outer oxide layer. Tensile tests showed the modifications did not affect the tensile properties of the material. The unmodified alloys and those with only 2% titanium suffered severe sulfidation in the experimental atmosphere. In other tests, ferrite stainless steels modified with aluminium and rare earth survived, while those modified with silicon were attacked. (LTN)

34388 Control system for apparatus to gasify fine-grain fuels in a reactor. Gernhardt, P.; Grams, W.; Danguillier, W.; Pohl, S. (to Otto and Comp. G.m.b.H.). US Patent 4,073,628. 14 Feb 1978. Priority date 18 Dec 1975, German, Federal Republic of (F.R. Germany). 8p.

Fine-grain fuel is delivered from pressure vessels with a vehicle gas as a fluidized flow into a reactor for gasification at an elevated pressure. A gaseous gasification agent is also fed into the reactor. A control system for the fine-grain fuel and gasification agent includes detectors to provide an electrical signal which varies during feeding of fuel from the pressure vessels into the reactor. Controllers produce a fuel rate control signal corresponding to a comparison between the electrical signal from the detectors and a predetermined reference value corresponding to the desired fuel supply rate. Control valves respond to the fuel rate control signal to adjust the supply of vehicle gas to transfer fuel from the pressure vessels into the reactor. When a plurality of pressure vessels is used, then separate detectors, controllers and control valves form part of a control system which further includes computing means to provide a summation signal corresponding to the output signals from the various detectors. The summation signal is used by the various controllers for adjusting the control valves associated with each pressure vessel. A further controller produces a gasification agent control signal in response to a comparison between the summation signal and a predetermined reference value corresponding to a desired supply rate of gasification agent into the reactor. A control valve is operated in response to the gasification agent control signal. The control system further includes a gas analyzer responsive to the gaseous product from the reactor to monitor the supply of gasification agent into the reactor and adjust the supply thereof to the reactor.

34389 Coal gasification process with improved procedure for continuously discharging ash particles and apparatus therefor. Funk, E.D. (to Kamyr Inc.). US Patent 4,073,629. 14 Feb 1978. Priority date 30 Jul 1974, South Africa. 16p.

A process is disclosed for producing gas from gas producing material, such as coal, within a gasifier by continuously heating the material under pressure to produce gas and ash particles, and continuously discharging the ash particles from the gasifier, the continuous discharging comprising the steps of confining a liquid, such as water or the like, within a first path including a volume having a free surface in communication with the gas pressure at the ash particle discharge end of the gasifier, substantially continuously discharging the ash particles into the aforesaid volume of water through the free surface thereof, maintaining a continuous flow of water along a second path at an energy level reduced with respect to the energy level of the water in the first path and continuously removing successive incremental volumes of ash particles entrained in water from communication with the first path and communicating the successive incremental volumes of water and entrained ash particles with the water flowing in the second flow path and apparatus therefor.

34390 Bi-gas process takes step toward reality. Weaver, R.A. Jr. *Gas Dig.;* 4: No. 2, 19-20(Feb 1978).

The Homer City, PA, Bi-Gas pilot plant is one of 5 High-Btu Gas pilot plant projects in USA. The overall program and auxiliary processes for coal gasification are described. (DLC)

34391 Gasification process with zinc condensation on the carbon source. Cottle, J.E. (to Phillips Petroleum Co.). US Patent 4,070,160. 24 Jan 1978. Filed date 9 May 1977. 8p.

In a process for gasifying solid carbon sources such as coal utilizing zinc oxide as the oxygen donor, the carbon source is first contacted in a preheat zone with product gas; any zinc in this product gas is condensed on the carbon source; the preheated carbon source and zinc are then exposed to steam whereby the zinc is oxidized to zinc oxide; the mixture of zinc oxide and carbon source finally is reacted at elevated temperature conditions to form a gas comprising carbon monoxide and zinc.

LIQUEFACTION

REFER ALSO TO CITATION(S) 34335, 34383, 34384, 34510, 34841

34392 (BNL—50707) **Flash hydropyrolysis of coal. Quarterly report No. 2, April 1—June 30, 1977.** Fallon, P. (Brookhaven National Lab., Upton, N.Y. (USA)). Jul 1977. Contract EY-76-C-02-0016. 45p. Dep. NTIS, PC A03/MF A01.

With the combination of low hydrogen to coal ratio, high coal feed rate and larger total quantity of coal fed, considerable liquid product is being condensed and collected. Experimental runs conducted at 750°C and 800°C at pressures up to 3000 psi of hydrogen show overall hydrocarbon yields and particularly gaseous hydrocarbon yields to increase with pressure to approximately 60 percent at 3000 psi. At 750°C approximately one third (20 percent) of this yield is in the form of liquid products (half BTX and half greater than or equal to C_9) while at 800°C the yield is almost all methane with less than 3 percent of liquids produced. Preliminary results of the effect of residence time on product yield and distribution shows that at 3000 psi of hydrogen and 800°C, gaseous product yield increase and liquid yields decrease as the residence time is increased from 2.3 to 9.2 seconds. Under almost identical conditions at 750°C, all product yields increased with approximately the same increase in residence time. Economic studies of the Flash Hydropyrolysis Process (FHP) are continuing. A detailed analysis of a 25,000 ton/day coal conversion plant utilizing FHP shows the discounted cash flow (DCF) to be strongly dependent upon the operating pressure of the reactor, increasing by almost a factor of two as the pressure is reduced from 4000 psi to 500 psi. The DCF is also shown to be influenced by the distribution of products, increasing as the yields of liquids increase.

34393 (COO—0056-2) **Synthoil hydrodynamics. Combined third and fourth quarterly report, December 1, 1975—May 31, 1976.** Brenner, H.; Prieve, D.C.; Fitch, B. (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA). Dept. of Chemical Engineering). Aug 1977. Contract EY-76-S-02-0056. 75p. (COO—0056-3). Dep. NTIS, PC A04/MF A01.

Portions of document are illegible.

This report deals with two-phase flow (gas and liquid) in a packed bed in the synthoil process reactor and preheater; in particular, nonuniform radial distribution of the liquid phase is studied. In addition, temperature profiles and possible instability of control due to the exothermic reactions are studied with respect to the synthoil reactor. This factor may limit the reactor diameter to about six inches. (LTN)

34394 (FE—1759-5) **Commercial conceptual design and commerical feasibility evaluation for clean boiler fuel facility. Capital cost validation of COALCON report/cost estimate, June 1977.** (Army Engineer Div., Huntsville, Ala. (USA)). 1 Dec 1977. Contract EX-76-C-01-1759. 36p. Dep. NTIS, PC A03/MF A01.

The US Army Engineer Division, Huntsville (USAEDH) has reviewed, validated, and updated a capital cost estimate of the Commercial Clean Boiler Fuel Coal Conversion Plant prepared by COALCON Company, New York, NY. This facility was designed to have a feed rate of approximately 30,000 tons of coal per day and is expected to produce approximately 15,000 barrels per day of heavy fuel oil, 6,000 barrels per day of raw gasoline, 5.5 million standard cubic feet per day of LPG, 135 million standard cubic feet per day of pipeline gas, 87 short tons per day of dark sulfur, and 545 short tons per day of bright sulfur. Capital cost was estimated by COALCON to be 604.5 anti M based on mid-1977 dollars. This estimate was revised by COALCON in September of 1977 to be 540.7 anti M based on mid-1977 dollars. Evaluation by USAEDH

resulted in a fixed capital cost of 575.7M for the facility based on mid-1977 dollars. The overall accuracy factor of the COALCON estimate was determined to be plus or minus 6.5 percent.

34395 (FE—2353-14) **EDS coal liquefaction process development: Phase IIIA. Quarterly technical progress report, January 1—March 31, 1977.** Fant, B.T. (Exxon Research and Engineering Co., Baytown, Tex. (USA). Baytown Research and Development Div.). Dec 1977. Contract EX-76-C-01-2353. 218p. Dep. NTIS, PC A10/MF A01.

Run length with Wyoming coal is extended dramatically by increasing the solvent-to-coal ratio, but is not significantly increased by operating at high slurry space velocity, at low reactor residence time, or at low temperature/high pressure reactor conditions. The one ton-per-day Coal Liquefaction Pilot Plant (CLPP) configuration was modified to produce unhydrotreated solvent and naphtha from Illinois No. 6 coal. Seven yield periods were completed in the new configuration. Engineering studies were conducted on the CLPP to confirm the design of the 250 ton-per-day Exxon Coal Liquefaction Plant (ECLP). Recycle solvent hydrotreating catalyst activity maintenance studies indicate that the temperature increase required (TIR) to maintain constant product quality is about 0.2 °F/day for both HDS-9A (Ni/Mo) and Nalcomo 477 (Co/Mo) catalysts. An early version of an empirical solvent hydrogenation model has been updated to account for hydrotreating limitations. The new version also estimates solvent quality, off gas generation, heteroatom removal, hydrogen consumption and catalyst deactivation. Bench scale product quality studies were mainly directed at evaluating potential disposition schemes for the naphtha and vacuum gas oil products to be produced in 250 ton-per-day ECLP. Other studies included evaluation of hydrofined coal middle distillates as home heating oil and compatibility studies on raw and hydrofined coal vacuum gas oils with petroleum heavy fuel oils. Preliminary hydrofining results indicate that conventional petroleum hydrofining catalysts and technology are applicable to coal liquids.

34396 **Coal processing system for reducing the amount of insoluble coal products in a light fraction stream.** Leonard, R.E. (to Kerr-McGee Corp.). US Patent 4,070,267. 24 Jan 1978. Filed date 1 Jun 1976. 14p.

An improved system for processing coal wherein a feed mixture (comprising a dissolving solvent, insoluble coal products and soluble coal products) is separated in a first separation zone, provided with a coalescing section, into a first heavy fraction and a first light fraction (comprising soluble coal products, the dissolving solvent and some insoluble coal products), and a portion of the insoluble coal products is separated from the first light fraction by contacting at least the first light fraction with the coalescing section. Such contacting reduces the amount of insoluble coal products in the first light fraction withdrawn from the first separation zone.

34397 **Solvent recovery in a coal deashing process.** Davis, R.E.; Baldwin, R.A. (to Kerr-McGee Corp.). US Patent 4,070,268. 24 Jan 1978. Filed date 1 Jun 1976. 8p.

An improved coal deashing process wherein coal is mixed with a first dissolving solvent, heated, solubilized and flashed to provide a prepared mixture. The flashing is effected at a temperature below about 650°F to increase the amount of the first dissolving solvent in the prepared mixture. The prepared mixture then is mixed with a second dissolving solvent to produce a feed mixture which is subjected to two or more successive phase separations. Insoluble coal products present are separated from the feed mixture in a first separation zone and the soluble coal products are recovered from the first and the second dissolving solvents in a second separation zone. The second dissolving solvent is recovered from the first and the second heavy fractions and the second light fraction for recycling to aid in producing the feed mixture. The first dissolving solvent is recovered from the first and second flash zones. This results in an enhanced recovery of the first dissolving solvent for recycle for utilization in the initial solubilization of the coal.

BY-PRODUCTS

REFER ALSO TO CITATION(S) 34911

PROPERTIES

REFER ALSO TO CITATION(S) 34340, 34370, 34699

34398 (ANL—78-7, pp 162-193) **Coal stream composition analysis for process control using prompt neutron activation analysis.** Gozani, T.; Reynolds, G.; Elias, E.; Maung, T.; Bozorgmanesh, H.; Orphan, V. (Science Applications, Inc., Palo Alto, CA). 1977.

From Symposium on instrumentation and control for fossil demonstration plants; Chicago, IL, USA (13 Jul 1977).

In Proceedings of the 1977 symposium on instrumentation and process control for fossil demonstration plants.

In this paper we describe early results of a series of laboratory experiments and computer modeling studies designed to provide realistic accuracy limits for the determination of the elemental concentration in coal using prompt neutron activation analysis. The results provide guidance for optimizing the technique for monitoring the quality of coal which is being input to an electric power generating plant. The reported work was performed as the initial phase of an ongoing program to develop a prototype on-line coal analyzer based on the PNAA technique for power plant application.

34399 (CONF-770652—, pp 335-341) **Electrical properties of coal as a function of temperature and frequency, polarization, and direction of the electromagnetic wave for UCG application.** Balanis, C.A.; Jeffrey, J.L.; Yoon, Y.K. (West Virginia Univ., Morgantown). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

The development of electromagnetic systems to detect and monitor an in-situ underground coal gasification process requires a knowledge of the electrical properties of coal. Using a two-path interferometer at microwave frequencies (approximately equal to 9 GHz), the samples were tested as a function of temperature, electric field polarization and direction of the coal samples. There were not any significant changes in the electrical properties of coal as a function of temperature from ambient up to 700°F. However, there were significant variations in the conductivity as a function of polarization, with the vertical polarization possessing lower conductivity. Only slight changes in conductivity were detected as a function of direction, with the butt cleats exhibiting somewhat lower losses. The dielectric constant remained essentially constant, within the measuring accuracy. Measurements of electrical properties of coal were also made in the 0.5—100 MHz region using capacitance techniques. In general, there was a decrease in the values of dielectric constant and an increase in conductivity as the frequency increased.

34400 (CONF-780305—14) **Separation of mutagenic components in synthetic crudes.** Guerin, M.R.; Ho, C.H.; Clark, B.R.; Epler, J.L.; Rao, T.K. (Oak Ridge National Lab., Tenn. (USA)). 1978. Contract W-7405-ENG-26. 4p. Dep. NTIS, PC A02/MF A01.

From Division of fuel chemistry meeting; Anaheim, CA, USA (12 Mar 1978).

Mutagenic, basic constituents of a synthetic coal oil and a shale oil were isolated from the crude mixtures. In arriving at an efficient isolation procedure, several liquid chromatographic packing-eluent combinations were tried and the fractions bioassayed to determine the distributions of the mutagenic components. The most effective separation was achieved using a sequential elution scheme with first an alumina-benzene combination followed by a Sephadex LH-20 gel-isopropanol-acetone system. About 75 to 80% of an ether soluble base is eluted with benzene through alumina (activity I). Analysis of this fraction has revealed a wide range of alkyl substituted quinolines and pyridines. Material remaining on the alumina column was eluted with ethanol, dried and placed on the Sephadex column. Isopropanol (approximately 250 ml) and acetone (approximately 600 ml) were used in that order to elute the material quantitatively. About 12% of the ether-soluble base is eluted with the isopropanol while the rest (approximately 10%) is eluted with the acetone. Additional alkyl pyridine compounds are eluted with isopropanol while the acetone fractions are predominantly multi-ring nitrogen heterocyclic compounds, according to mass spectral analyses. Bioassay data show excellent isolation of the mutagenic activities into the acetone fractions. Negligible activity is found in the sum of the other (90% wt) fractions.

34401 (COO—4129-4) **Measurement of the flow properties and capillary pressure relationships of certain coals pertaining to underground coal gasification. Quarterly report, June—August 1977.** Fulton, P.F.; Reznik, A.A. (Pittsburgh Univ., Pa. (USA). Dept. of Chemical and Petroleum Engineering). Sep 1977. Contract EY-76-S-02-4129. 32p. Dep. NTIS, PC A03/MF A01.

Gas-phase permeabilities of five samples from the Hanna IV site were measured as functions of water saturation. These samples were cut from a core which was obtained in-situ at a subsurface depth of approximately 335 feet. In addition effective permeabilities to water were measured over an increasing water saturation cycle for three Hanna and two Pittsburgh coals obtained from surface mines. Absolute permeabilities to gas as a function of overburden pressure were measured for one additional Hanna surface sample. Preliminary results of carbon dioxide flows through the three coals are briefly discussed.

34402 (FE—2030-TR5) **Survey of selected agencies conducted to determine the extent to which the nation's coals are adequately characterized.** Hower, J.M.; Davis, A.; Dolsen, C.P.; Spackman, W. (Penn-

sylvania State Univ., University Park (USA). Coal Research Section). Oct 1977. Contract EX-76-C-01-2030. 50p. Dep. NTIS, PC A03/MF A01.

A survey was conducted to determine the extent to which the nation's coals were adequately characterized. Questionnaires were sent to 81 agencies in the coal community selected to form a representative cross section of the organizations concerned with coal characterization. Fifty-nine completed questionnaires were received. Respondents included representatives of the agencies with the longest experience in characterization and those in the best position to know the status of our knowledge of the composition and properties of the coals comprising the country's coal fields. Analysis of the responses to the questionnaire resulted in the following conclusions: The nation's coals are inadequately characterized for their efficient and effective use, particularly in relation to coal conversion technology and maintaining environmental quality; the number of agencies conducting coal characterization programs is too small to meet the nation's needs within the time frame required; and the scope of coal characterization programs should be expanded to develop a broader spectrum of basic compositional and performance data.

34403 Forward-scattered gamma radiation in ash-content monitoring for moving coal (exhange of experience). Vasil'ev, A.G.; Onishchenko, A.M.; Slavinskii, V.M.; Kuznetsova, A.I. (Mining Inst., Moscow). *Ind. Lab. (USSR) (Engl. Transl.);* **43**: No. 4, 564-566(Apr 1977).

Translated from Zavod. Lab.; 43: No. 4, 476-477(Apr 1977).

A method is described for monitoring the ash content of a moving sample of coal by forward scattering of the γ radiation from an ^{241}Am source. The sample is a separate flow of material, which should be a consolidated flow extracted from the main flow, carried by a conveyor belt of any size, and the sample is a rectangular cross section with the surface roughly leveled. An efficient contactless transducer is used for the monitoring.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 34410, 34411, 34467, 34483, 34915, 34916, 34919, 34929, 34932, 34933, 34936, 34937, 34938, 35935

34404 (ANL—78-7, pp 256-272) **On-line particulate analysis for advanced combustion systems.** Van Valkenburg, E.S. (Leeds and Northrup Co., North Wales, PA). 1977.

From Symposium on instrumentation and control for fossil demonstration plants; Chicago, IL, USA (13 Jul 1977).

In Proceedings of the 1977 symposium on instrumentation and process control for fossil demonstration plants.

An on-line particulate analyzer has been designed for measurement of particles in high temperature, pressurized gas streams. A prototype instrument has been constructed and calibrated. It is scheduled for operational tests at Argonne National Laboratories and later at Curtiss Wright Corporation. A summary of the instrument specifications is presented.

34405 (CONF-7710113—, pp 141-151) **Economic evaluation of coal refuse disposal systems.** Brown, R.E. (Law Engineering Testing Co., McLean, VA); Wilson, T.C.; Thomasson, D.L. 1977.

From 3. symposium on coal preparation; Louisville, KY, USA (18 Oct 1977).

In Third symposium on coal preparation.

Cost evaluations have been conducted for three complete systems to dispose of coal refuse from wet preparation plants. Preliminary designs of the alternate disposal systems were developed by Law Engineering based on experience with comparable design situations. Actual costs from operating plants owned by American Electric Power Service Corporation Fuel Supply were used to develop these comparative cost analyses for a single operating plant. The costs developed illustrate that refuse disposal currently costs on the order of $1.50 to $2.00 per ton of refuse for a relatively large and efficient operation. This direct cost is significant and is even greater in smaller, less efficient and poorly planned operations. The least expensive disposal system is still a coarse refuse impoundment despite the various regulations that govern construction and operation of impoundments. However, regardless of the disposal system selected, total and operating costs can be significantly reduced by comprehensive engineering design. Such engineering design and optimization studies are required to comply with the regulatory requirements, while achieving an economical operation. Selection of a refuse disposal system for a proposed plant must also consider several items beyond the scope of this paper. First, the technical feasibility of a given disposal system must be verified. It may also be advantageous to consider underground disposal, etc. Secondly, the capital investment and cash flow requirements must be considered. Thirdly, the materials handling and transportation system is the most significant factor affecting the refuse disposal cost. Therefore, the use of trucks, belts, trams, pipes, etc. must be optimized for a given site to achieve the minimum cost operation.

34406 (CONF-7710113—, pp 152-162) **Recent developments in reprocessing of refuse for a second yield of coal.** Maneval, D.R. (Appalachian Regional Commission, Washington, DC). 1977.

From 3. symposium on coal preparation; Louisville, KY, USA (18 Oct 1977).

In Third symposium on coal preparation.

There has been a renewed interest in the reprocessing of old coal refuse banks for a second yield of coal. Following World War II, various technical and economic factors again led to the processing of anthracite refuse disposal sites. Until recently, most secondary coal recovery operations were in the anthracite area of Pennsylvania. Bituminous refuse banks have been worked from time to time for blending refuse material with current coal production. A waste coal pile or culm bank is heterogeneous rather than homogeneous in composition and variation will occur, both horizontally and vertically. Culm bank materials will generally consist of coal, shale, bone coal, sulfates, carbonates and pyrite or marcasite. In addition, slag materials may be present if combustion of portions of the bank has occurred. The variability of material in a coal refuse pile depends on many factors, such as, the market for coal, method of cleaning, efficiency of the cleaning process, mining methods and systems employed and the quality of the coal seam. The most important conclusion to be drawn from this is that extensive sampling, both on the surface and at depth, has to be performed before accurate estimates can be made as to the fuel value of a refuse pile. The coal shortage of last winter, coupled with increased production costs, have made the reworking of coal refuse banks and the recovery of coal from preparation plant slurry settling ponds very attractive. A review made recently by the Pennsylvania Department of Environmental Resources of surface mining permits indicated permits have been issued for processing coal from at least 17 bituminous refuse disposal sites and there were about 35 similar operations in the anthracite coal area of Pennsylvania.

34407 (CONF-7710113—, pp 164-167) **Construction guidelines for pollution control from coal refuse piles and slurry ponds.** Connell, J.P. (Wahler and Associates, Palo Alto, CA). 1977.

From 3. symposium on coal preparation; Louisville, KY, USA (18 Oct 1977).

In Third symposium on coal preparation.

In compiling the information on construction practices applicable to pollution control from coal refuse disposal sites, several conclusions were reached. Among the most significant were: (1) There are a large number of responsible coal operators most of whom have been using good pollution control techniques for years. The prevailing image of the entire coal industry being major polluters who are destroying our land and polluting our water is unfair to the number of conscientious mine operators who began using good pollution control techniques long before environmental concern became a vogue. It is important to put this matter into perspective and to give credit where it is due in order to encourage good practices through pride, rather than only through regulation. (2) Acid drainage from old refuse piles and erosion of steep, exposed refuse banks is generally a more serious pollution control concern than uncontrolled release of suspended solids from slurry ponds. (3) Ignition or burning of coal refuse is a problem restricted to older deposits. Present compacted layer placement procedures, decreased air permeabilities of placed refuse, and the substantially lower percentage of coal in refuse piles have combined to minimize the problem of refuse fires from the modern disposal operations. Extinguishing fires and keeping them extinguished in some of the older refuse deposits still remains a serious concern. In many areas of Appalachia, flat, usable land is at a premium. With proper planning and construction control, coal refuse sites are being developed so that restored land can be put to useful purposes resulting in an improved environment and an economic asset instead of a liability.

34408 Acid mine drainage treatment with rotating biological contactors. Olem, H.; Unz, R.F. (Pennsylvania State Univ., University Park). *Biotechnol. Bioeng.;* **19**: No. 10, 1475-1491(Oct 1977).

A pilot scale rotating biological contactor (RBC) was set up near a coal mine at Hollywood, Penn. to evaluate ferrous iron, Fe(II), oxidation. Acid drainage from this mine entered the treatment unit which consisted of four sets of plastic disks affixed to a rotating central shaft. As the disks rotated half immersed in the flowing mine water, iron-oxidizing bacteria, presumed to be Thiobacillus ferrooxidans, colonized the disk surfaces with an average population of 70,000 cells/cm^2 and mediated the transformation of Fe(II) to the less soluble ferric state, Fe(III). Kinetics of microbial Fe(II) oxidation were established during an eleven month period of continuous pilot operation and were found to follow a concentration dependent first order relationship. Operating at an optimum disk rotation rate and hydraulic loadings of 2.7 and 5.4 gal/day-ft^2 (0.11 and 0.22 m^3/day-m^2) resulted in the oxidation of an average 240 mg/liter influent Fe(II) to produce effluent Fe(II) of 2 and 5 mg/liter, respectively. The RBC appears potentially useful as a first step in the total treatment of acid mine drainage.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 34344, 34376, 34377, 34378, 34380, 34660, 35938

34409 (ANL—78-7, pp 315-321) **Environmental monitoring in coal conversion.** Massey, M. (Carnegie-Mellon Univ., Pittsburgh). 1977.

From Symposium on instrumentation and control for fossil demonstration plants; Chicago, IL, USA (13 Jul 1977).

In Proceedings of the 1977 symposium on instrumentation and process control for fossil demonstration plants.

ERDA has assembled a major environmental assessment program effort at its high Btu coal gasification pilot plants the results of which will be of direct value to those interested in the environmental monitoring of larger scale demonstration and commercial scale plants.

34410 (CONF-7710112—) **Seventh symposium on coal mine drainage research. NCA/BCR coal conference and Expo IV.** (National Coal Association, Washington, D.C. (USA); Bituminous Coal Research, Inc., Monroeville, Pa. (USA)). 1977. 264p. Dep. NTIS, PC A12/MF A01.

From 7. symposium on coal mine drainage research; Louisville, KY, USA (18 Oct 1977).

The Seventh Symposium on Coal Mine Drainage Research, sponsored by the National Coal Association and Bituminous Coal Research, Inc., was held at the Kentucky Fair and Exposition Center, Louisville, Kentucky, October 18-20, 1977. Seventeen papers from the proceedings have been entered individually into EDB and ERA. Topics covered include chemical reactions of pyrite oxidation and acid formation in spoil banks, abandoned mines, etc., formation of small acid lakes from the drainage and their neutralization by natural and other neutralization measures, trace elements in acid mine drainage, ground water contamination, limnology, effects of surface mined ground reclamation and neutralization, water purification and treatment, mining and coal preparation plant waste disposal, ash and fly ash disposal (to minimize leaching from the wastes), runoff from large coal storage stockpiles during storms (prevention of environmental effects by collection and neutralization by passing through an ash pond). (LTN)

34411 (CONF-7710112—, pp 1-4) **Priority pollutant effluent standards and the coal industry.** Telliard, W.A. (Environmental Protection Agency, Washington, DC). 1977.

From 7. symposium on coal mine drainage research; Louisville, KY, USA (18 Oct 1977).

In Seventh symposium on coal mine drainage.

On June 7, 1977 in response to a lawsuit filed by several environmental groups, the Environmental Protection Agency signed a Settlement Agreement for the management of dangerous pollutants in industrial waste waters. Also signing that court order as an intervening defendant was the National Coal Association. With the establishment of this court consent degree, a broad program of action was initiated. Under the terms of this Settlement Agreement, filed in the United States District Court for the District of Columbia, EPA is required to develop effluent limitations guidelines, new source performance standards and pretreatment rules for 21 industries controlling the discharge of 65 chemicals and chemical classes believed to include the most danagerous substances commonly released into the environment. Coal Mining and Ore Mining are among the 21 industries scheduled for study. The coal mining technical study was initiated December 31, 1977 with a duration of one year. The scheduled deadline for proposing coal mining effluent limitations is September 30, 1978. EPA's strategy and plans for meeting the obligations of the Settlement Agreement are detailed. Final rules for all industries must be published by December 31, 1979.

34412 (CONF-7710112—, pp 25-40) **Acid generation within a spoil profile: preliminary experimental results.** Rogowski, A.S. (Dept. of Agriculture, University Park, PA). 1977.

From 7. symposium on coal mine drainage research; Louisville, KY, USA (18 Oct 1977).

In Seventh symposium on coal mine drainage.

Preliminary results after initial water application to two caissons filled with mine spoil showed a much higher infiltration rate and settling on spoil alone than on spoil covered with soil. Considerable piping and internal erosion tended to transport large amounts of soil material deep into spoil profiles. Temperature profiles reflected water movement, while O_2 concentration values decreased when soil covered the spoil surface. Determination of organic C in spoil materials, using conventional methods seemed questionable. Although S contents within a spoil profile undoubtedly were related to acid generation, the highest S content (acid shale, caisson 2) did not seem to generate exceptionally high acid effluent. Apparently adequate topsoil cover (caisson 1) improved the quality of water reaching the water table. Possibly, piping and erosion could have created an internal filter and the results suggest that under controlled field conditions a similar filter may form. Since topsoil cover seemed to reduce substantially oxygen diffusion, less oxidation and acid generation with depth might be expected on soil reclaimed according to a new Pennsylvania law. The study results showed that organic C and leaching analyses of individual layers might not truly reflect the field situation. Organic C may often be contaminated with coal or organic shale fragments, while a cumulative profile effluent seemed to contain considerably higher concentration of salts than combined leachates from the individual layers.

34413 (CONF-7710112—, pp 41-50) **Time as a factor in acid mine drainage pollution.** Geidel, G.; Caruccio, F.T. (Univ. of South Carolina, Columbia). 1977.

From 7. symposium on coal mine drainage research; Louisville, KY, USA (18 Oct 1977).

In Seventh symposium on coal mine drainage.

The degree of acidity in coal mine drainage is a function of a balance between the amount of acidity produced and the alkalinity production potentials. The acidity is derived primarily by the oxidation of reactive pyrite and the subsequent dissolution and hydrolysis of the weathering products. The alkalinity, on the other hand, is produced by a dissolution reaction between calcium carbonate and water. The kinetics of both systems are markedly different and the concentrations of acid or alkalinity are time dependent. In the following geochemical system we assume that the material producing alkalinity is hydrologically antecedent of the acid producing material. Recent simulated weathering tests of acid and alkaline producing rocks showed that the rates of reactions of the two systems were markedly different. The amount of acidity produced by frequent flushings produced less acid than flushings which were done at longer time intervals. Thus, we found that frequent flushings commonly produced mildly acidic leachates. Alkalinity production, however, is limited by the solubility of calcium carbonate in water which, at a given partial pressure of carbon dioxide, has a maximum neutralizing potential. These relationships suggest that the length of time between flushing intervals is critical to the prevention of acidic drainages in strip mines that contain potentially neutralizing material. Regardless of the time interval of flushing, the maximum alkalinity produced by calcareous material is rapidly achieved and remains relatively constant. Subsequently, frequent flushings of acidic material prevent the accumulation of oxidation products and produce mildly acidic drainages that can be neutralized by the available alkalinity. On the other hand, infrequent flushings solubilize larger concentrations of oxidation products producing strongly acidic solutions which overwhelm the available alkalinity and produce acid mine drainage.

34414 (CONF-7710112—, pp 51-60) **Environmental pollution by trace elements in coal preparation wastes.** Williams, J.M.; Wewerka, E.M.; Vanderborgh, N.E.; Wagner, P.; Wanek, P.L.; Olsen, J.D. (Los Alamos Scientific Lab., NM). 1977.

From 7. symposium on coal mine drainage research; Louisville, KY, USA (18 Oct 1977).

In Seventh symposium on coal mine drainage.

Coal preparation waste contains a multitude of leachable elements. Data for 18 elements are presented here. Generally these elements occur in the waste leachates at levels related to their occurrence in the waste. Closer inspection reveals, however, that some elements are much more leachable than others. Thus, for Illinois-Basin waste iron is found to be present in waste leachate in high amounts, but this amount represents only a small percentage of the total iron in the waste. Cobalt and nickel, on the other hand, are not very plentiful in the waste, but are highly leachable. Aluminum, a major constituent of clays in the waste, is very poorly leached. Oxygen availability is a prime factor in the production of soluble iron which is readily flushed from the waste. Particle size is less important. Under damp conditions and with plenty of air, pyrite oxidizes rapidly. This latter situation poses a problem for the plant operator, as coal preparation wastes are discarded damp and remain so via rainstorms for long periods before they are covered.

34415 (CONF-7710112—, pp 61-70) **Acid lake renovation.** Rosso, W.A. (Peabody Coal Co., Central City, KY). 1977.

From 7. symposium on coal mine drainage research; Louisville, KY, USA (18 Oct 1977).

In Seventh symposium on coal mine drainage.

The experience with these five lakes has demonstrated that acid lakes can be successfully and economically renovated. Lakes serve as large collection basins for their watershed so the quality of water in the lake is simply a reflection of the physical, chemical and biological processes within the watershed. Acid mine drainage formation does not take place in the lake but rather in the spoil piles. If the lake is eliminated, the problem is exacerbated by the system producing more silt, greater peak flows of floods, higher metal concentration in water, loss of carrying capacity of wildlife and the ecosystem being simplified by the loss of the aquatic community. Renovated spoil lakes have several good effects which are listed. Limestone was chosen for the neutralizing agent because: (1) it is a

relatively inexpensive material, (2) it is natural material in watersheds forming a bicarbonate buffer system, and (3) unreacted material will be present for an extended period to contribute alkalinity to the bicarbonate buffer system. The biological community of an acid lake is a meager, simplified community and as such supports a short food chain and simplified food web. The food web in the renovated lakes illustrates the complexity and varied interconnection between different groups of organisms. This species variety gives stability to the ecosystem. The type of aquatic community that develops once an acid lake has been renovated is perhaps the best barometer of the health of that ecosystem. By working with the various ecological processes already in progress in the watershed, the system will respond rather quickly. Two goals which are foremost in Peabody's Reclamation Program are to: eliminate any offsite damage; and return the reclaimed land to a stable ecological unit in the shortest time-frame possible.

34416 (CONF-7710112—, pp 71-87) **Groundwater re-establishment in cast overburden.** Herring, W.C. (AMAX Coal Co., Indianapolis). 1977.

From 7. symposium on coal mine drainage research; Louisville, KY, USA (18 Oct 1977).

In Seventh symposium on coal mine drainage.

Climate plays a major role in post-mining reclamation, and in the restablishment of surface water and groundwater. Overburden characteristics may vary considerably from one area to another, and must be studied carefully before mining. In most cases the overburden has a neutralization potential exceeding the acid-producing potential. As a result of surface mining the overburden is changed from a sedimentary layered sequence of distinct rock types in a generally well-consolidated state to a heterogeneous mixture of pieces of rock of quite variable size. The overall volume of the cast overburden is about 20 percent greater than that of unmined overburden, and the cast overburden is now being capped with top soil. Studies to date indicate cast overburden aquifers have greater transmissivities, greater recharge and greater discharge than do aquifers in the unmined overburden. Generally speaking, groundwater recharge occurs in topographic highs and discharge occurs in topographic lows. The net result of these present and reclamation practices is to cause more surface-water runoff and erosion from reclaimed areas following precipitation. Recharge to shallow aquifers is essentially derived from local precipitation which percolates downward through the soil and other overburden materials. Greater groundwater recharge and runoff will occur in those areas extensively mined. The groundwater in cast overburden will have higher dissolved solids and much of the increase will consist of sulfates. This is not to say that the water will become unfit for use, but that it will differ from water in unmined areas.

34417 (CONF-7710112—, pp 88-103) **Investigation of ion exchange treatment of acid mine drainage.** Wilmoth, R.C.; Scott, R.B.; Kennedy, J.L. (Environmental Protection Agency, Cincinnati). 1977.

From 7. symposium on coal mine drainage research; Louisville, KY, USA (18 Oct 1977).

In Seventh symposium on coal mine drainage.

This paper discusses briefly several ion exchange treatment schemes conceived for the production of a potable water from acid mine drainage and presents specific data from research on one of these processes studied recently by EPA at the Crown Mine Drainage Control Field Site near Morgantown, West Viriginia.

34418 (CONF-7710112—, pp 104-123) **Chemical limnology of an acid mine drainage sludge settling impoundment.** McDonald, D.G. Sr. (Peabody Coal Co., St. Louis). 1977.

From 7. symposium on coal mine drainage research; Louisville, KY, USA (18 Oct 1977).

In Seventh symposium on coal mine drainage.

A stripmine lake in southeastern Illinois was intensely studied from February to August 1972 to (1) characterize chemical and physical stratification; (2) determine the "stability" of stratification and (3) assess the relationship between impoundment stratification and the primary influent source—neutralized acid mine drainage from the Will Scarlet water treatment plant (USEPA—Peabody Coal Company Project No. 14010 DAX). The sludge settling impoundment was characterized as a unique example of an artificially induced crenogenic maromictic (partly-mixing) impoundment. Dichotomized pH stratification and the subsequent accumulation of iron (ferrous) bicarbonates in the lower strata indicated that the origin and maintenance of impoundment meromixis was directly related to the deposition of iron hydroxides from the neutralization process as per the impoundment's intended use. Stability of impoundment stratification was compared to other types of meromictic lakes and found to be low in value. Moreover, observation of the study lake during treatment plant down-time further indicated a tendency toward holomixis (whole-mixing) with the appearance of iron solutes in upper lake strata.

34419 (CONF-7710112—, pp 124-138) **Effect of strip mine reclamation on an underlying mine pool outflow in the Southern Anthracite Coalfield, Pennsylvania.** Baskin, L.; Mead, J. (Dept. of Environmental Resources, Harrisburg, PA). 1977.

From 7. symposium on coal mine drainage research; Louisville, KY, USA (18 Oct 1977).

In Seventh symposium on coal mine drainage.

The Middle Creek Acid Mine Drainage Abatement Project presented an opportunity to evaluate the results of strip mine reclamation and surface flow diversion over an area covering an entire mine pool. Furthermore, the mine pool is controlled by a single outflow. The general improvement of quality in the mine pool water is primarily attributed to the reclamation project. Reduction of free air access, the total length of inflow paths, mine pool level fluctuation, and acid formation in spoil material are believed to be the major factors.

34420 (CONF-7710112—, pp 139-149) **Progress in methodology of the lignite mine waters purification.** Janiak, H. (Central Research and Design Inst. for Opencast Mining, Wroclaw). 1977.

From 7. symposium on coal mine drainage research; Louisville, KY, USA (18 Oct 1977).

In Seventh symposium on coal mine drainage.

Purification of mine waters in Poland is limited to reducing the excessive concentration of suspended solids to a level stipulated by regulations. The first phase of reduction takes place in the reservoirs or surge tanks of the pumping stations. Here some suspended solids settle out. Further reduction takes place in reservoirs (natural ponds) or artificial sedimentation basins constructed outside the mine pit or at the bottom of the excavation. In 1971 research commenced on the purification of lignite mine waters with the objective of improving the performance of existing sedimentation basins. The research was an analysis of the hydraulics of sedimentation basins and the process of the suspended matter reduction and its dependence on retention time and the distance of travel. The results showed that the retention time in sedimentation basins could be reduced from three days to 16 to 20 hours and equal performance obtained. In order to reduce the retention time the sedimentation within the basin must be correct in relationship to the flow and the construction of the inlet and outlet must be proper. These desired results could only be achieved with favorable atmospheric conditions, i.e., low wind velocities. Waters with a high content of fine sized suspended solids (the Turow mine) and other waters in inclement weather conditions could not be purified in sedimentation basins to the required level. Other methods to remove suspended solids from mine waters were investigated. The following methods appeared to have merit: gamma radiation, flocculation, filtration through sand beds, coagulation, and filtration through plants, i.e., so called grass filters. Studies on the first three processes were conducted in cooperation with the U.S. Environmental Protection Agency.

34421 (ORNL/TM—6261) **Fossil Energy Environmental Project. Annual report, FY 1977.** Braunstein, H.M. (ed.). (Oak Ridge National Lab., Tenn. (USA)). Apr 1978. Contract W-7405-ENG-26. 26p. Dep. NTIS, PC A03/MF A01.

During the past year the Fossil Energy Environmental Project has provided technical support to the Fossil Energy Program Administration of the Department of Energy (DOE/FE) in its coal conversion demonstration program. Work was focused in four principal areas: environmental assessment; guidance to demonstration plant contractors regarding environmental obligations; experimental studies of stored solids from coal conversion; and interactive assistance to contractors regarding environmental monitoring needs. Four major documents were prepared, two guidelines for contractors and two environmental analyses. An experimental program using both laboratory and field-scale testing was initiated to study leachates from both stored coal and coal conversion wastes. Technical assistance tasks early in the year consisted primarily of quick-response activities. However, after initial demonstration plant contracts were signed, advisory activities increased--the latter part of the year saw the start of frequent interactions with contractors regarding environmental monitoring of coal conversion demonstration-plant sites.

RESERVES AND EXPLORATION

REFER ALSO TO CITATION(S) 34375, 34568, 35390

34422 (CONF-770652—, pp 300-305) **Shallow high resolution seismic reflection profiling.** Shopland, R.C.; Farr, J.B. (Western Geophysical Co., Houston, TX). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

Rapid advances in high-resolution-seismic-reflection profiling instrumentation, field techniques and processing methods have been

realized in the past year. Field techniques are more precise. Noise attenuation techniques reduce high-line harmonics as well as fundamentals. Increased sensitivity of signal detectors allows detection of drastically attenuated high frequency reflections. Downhole detectors have field-selectable preamplifier response curves that produce a closer match with the inverse of the earth-response to provide increased dynamic range. Recording systems with an expanding-spread feature and programmable automatic switching of sampling rates provide high resolution reflection signatures at shallow depths without changing the deeper data. Shallow data can be used to improve weathering corrections. Having resolved fault displacements of less than 2 meters at a depth of 30 meters, this improved reflection technique shows promise as a tool for delineation of coal seams and structure in coal fields.

34423 **Use of reflectivity standards in an image analysis system.** Harris, L.A. (Oak Ridge National Lab., TN). *Microstruct. Sci.;* **5**: 303-309(1977).

The use of automated image analysis systems in performing coal petrography is being examined. A method for doing quantitative objective photometric analyses of the coal constituents has been explored. Reflectivity standards normally used in determining the reflectance of vitrinite in coal samples for ranking purposes were correlated with threshold control settings on Quantimet Models B and 720. A near-linear relationship was shown to exist between the percent reflectivity and threshold setting. The effects of variables such as wavelength, television image size, objective lens magnification, and use of oil or air objectives were studied.

MINING

REFER ALSO TO CITATION(S) 34406, 34488, 34489, 34490, 34491, 34492

34424 (CONF-7710111—) **Third symposium on underground mining.** (National Coal Association, Washington, D.C. (USA); Bituminous Coal Research, Inc., Monroeville, Pa. (USA)). 1977. 428p. Dep. NTIS, PC A19/MF A01.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

The Third Symposium on Underground Mining was held at the Kentucky Fair and Exposition Center, Louisville, KY, October 18—20, 1977. Thirty-one papers have been entered individually into EDB and ERA. The topics covered include mining system (longwall, shortwall, room and pillar, etc.), mining equipment (continuous miners, longwall equipment, supports, roof bolters, shaft excavation equipment, monitoring and control systems. Maintenance and rebuilding facilities, lighting systems, etc.), ventilation, noise abatement, economics, accidents (cost), dust control and on-line computer systems. (LTN)

34425 (CONF-7710111—, pp 1-8) **Development of an in-seam miner.** Hay, K.E. (Spokane Mining Research Center, WA); McNicol, J.B. 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

In Third symposium on underground mining.

A machine developed by the United Kingdom's National Coal Board was modified and is presently undergoing performance tests in the U.S. British experience with the equipment and the modifications made in it are described. (LTN)

34426 (CONF-7710111—, pp 9-24) **Recent developments in underground mining in Australia.** Johnstone, J. (Buchanan Borehole Collieries Pty. Ltd., Singleton, Australia). 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

In Third symposium on underground mining.

Although recent increases in production and productivity in Australian coal mining have largely been by surface mining methods, the industry is conscious of the fact that coal won by underground methods must increase. Australian coal reserves are quite large. The deposit's are described briefly and the mining methods used are reviewed. Various factors such as underground transport of coal, underground road design, spontaneous combustion, problems with thick seams, regulations for mining under water, etc. are discussed. (LTN)

34427 (CONF-7710111—, pp 25-41) **Helping finance new mines with revenues from coalbed degasification.** Deul, M. (Pittsburgh Mining and Safety Research Center); Skow, M.L.; Kim, A.G. 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

In Third symposium on underground mining.

Implementation of a national energy policy which calls for increased dependence on coal will require vastly expanded coal mining capacity. It is highly probable that new mines will be more expensive, requiring public financeing. To attract outside investment, the coal mining industry will have to lower risk, increase productivity, and sustain a high production rate. Many factors will determine whether this will be accomplished, but it will be particularly difficult if problems related to the gassy nature of deep coalbeds are ignored until they become crises. It can be reasonably expected that new, deep coal mines will experience very high methane emission rates, and dependence on ventilation alone to control methane emission will be ineffective and will result in lower productivity. Bureau of Mines experience with degasification of very gassy coalbeds, especially the Pittsburgh coalbed, has shown that coalbed degasification prior to mining will ameliorate gas problems during mining and will also generate additional revenue. In the example given here, for an additional investment of $2 million for degasification, more than $10 million was realized from the sale of drained gas. In other words, commercial gas production from coal through mine shafts makes monetary sense; it is technologically feasible, economically attractive, and will improve the profitability and reduce the hazards of coal mining. Degasification in advance of mining reduces the risk, both financial and physical, involved in mining the coal.

34428 (CONF-7710111—, pp 42-85) **Development of Blind Shaft Boring System.** Friant, J.E.; Sands, P.F. (Robbins Co., Seattle). 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

In Third symposium on underground mining.

The Bureau of Mines is adapting technology existing in tunnel boring industry to mechanize vertical shaft sinking with a Blind Shaft Borer (BSB). The tunnel boring manufacturers have made significant advancements in cutting rock, supporting openings, and mobilizing and demobilizing equipment, all of which is applicable to a shaft sinking machine. The Blind Shaft Boring system has been designed to bore and concrete line vertical coal-mine shafts up to 1,800 feet deep at rates up to 48 feet per day. The system will be demonstrated at a coal mine site in Alabama starting early in 1978. Final detail design has been completed and the machine is partly fabricated. The BSB incorporates basic concepts developed for the tunnel boring industry. The major difference, however, requires that the cuttings be collected at the face and transported to the top of the machine where they are transferred to a skip-hoisting system. A mechanical muck pickup system has been tested in a full-scale facility, and a pickup system now exists which is compatible with machine production goals. The machine will weigh about 350 tons and require about 1,000 horsepower. The cutterhead will be electrically powered, and the control system, e.g. grippers, guide shoes, torque reactors, and cutterhead advance cylinders will be powered hydraulically. The shaft will be ventilated with up to 50,000 cfm of air. Six operating personnel will be required in the shaft.

34429 (CONF-7710111—, pp 148-160) **Use of horizontal roof strain indicators to determine changes in top conditions and the effectiveness of anchor type roof bolts.** Rupert, G.B.; Clark, G.B.; Bajaj, S. (Univ. of Missouri, Rolla). 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

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Pairs of four-foot resin and mechanical anchor roof bolts (without collars) were installed in the top along the intake side of an active coal mine. To each pair of the same type was affixed a horizontal roof strain indicator or HORSI and the instrument readings monitored for a period of approximately four months. These values when fitted to a linear regression model suggest that the HORSI's mounted on resin bolts more accurately monitor day to day changes in roof top conditions while those mounted on anchor types not only indicate trends but provide information concerning day to day movement of the bolts in the bolt holes. Thus by the subtraction of the two sets of values, changes in anchor effectiveness may be estimated. As a consequence, it is recommended that both types be used for HORSI installations when a bolting program dictates that anchor type bolts are to be utilized.

34430 (CONF-7710111—, pp 180-189) **Optimum new mine maintenance.** Morgan, B.E. (U.S.S., Cumberland Coal, Waynesburg, PA). 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

In Third symposium on underground mining.

Attitude is the most vital ingredient to attain optimum maintenance in a new large mine such as Cumberland. This includes attitudes of officials toward maintenance and other services, attitudes of maintenance people towards the machines for which they are responsible and attitudes of operators toward their machines. The prevailing attitude of all concerned must be Preventative Maintenance. The ingredients of good maintenance are: proper machine selection, people selection and development, effective systems, adequate parts availability and proper location, careful production and maintenance scheduling, and accurate and complete records keeping. Long term success depends on a good rebuild program and scientific research and development, but most of all on unceasing vigilance.

The operating computer systems at Cumberland including the preventative Maintenance and parts systems were conceived by the maintenance group working with the headquarters Industrial Engineering group.

34431 (CONF-7710111—, pp 190-195) **Experience of Clinchfield's new Central Maintenance and Rebuilding Center.** Wilson, F.T. (Clinchfield Coal Co., Dante, VA). 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

In Third symposium on underground mining.

The Rebuild Center was designed to be the nucleus of Clinchfield Coal Company's maintenance program. The Center has the potential to rebuild any component or equipment used at Clinchfield or any of our sister companies in The Pittston Coal Group. The mainstay of the Center is the rebuild program. It was anticipated that the Center could more than triple rebuild capacity. As many as six major pieces of equipment can be in the process of being overhauled simultaneously. The main objective of the overhaul department is to redesign existing machines with the maintenance man in mind and to strengthen where parts have failed in the past. The chief electricians are called in from the mines whenever a major component from one of the thier mines comes in for overhaul to give comments on problems that they have encountered and to give possible solutions. Many components are being standardized such as cat chains, conveyor chains, gearing, bit patterns, canopies, water systems, methane monitors, line starters, remote control cables and hydraulic components. We found that many main frames on continuous miners were not designed heavy enough to withstand cutting rock, which is a daily routine at some of our operations. Design criteria for such miners is to calculate design requirements, then double for a safety factor, if feasible to do so. From only using standard size Stecho hydraulic hoses, we simplify our hosing problems tremendously. All fittings and hoses are kept on carts and are wheeled to wherever needed. Not as many hoses have to be kept in stock when only standard lengths are used, thus making assembly and maintenance work more efficient.

34432 (CONF-7710111—, pp 196-203) **Mine production equipment maintenance program performance evaluation.** Herron, R.D. (Island Creek Coal Co., Lexington, KY). 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

In Third symposium on underground mining.

There is probably no industry in which the maintenance of equipment is more difficult to accomplish or more important for efficient and effective production needs than that in underground coal mining. The equipment is very expensive and the conditions under which it is used and maintained are extremely difficult when compared to most any other industry. Maintenance's basic objective is generally understood to be the administration and efficient accomplishment of all inspection, preventive maintenance, repair, overhaul, remodeling, improving and evaluation for salvage or replacement of facilities and equipment. Preventive maintenance is probably the area in which the maintenance function can effect the greatest overall improvement in operating and production cost per unit of performance. Equipment frequently and suddenly rendered unserviceable because of breakdown is not only costly in terms of lost production but also the total cost or result may be much greater than the apparent loss due to the effect on shipment schedules, customer quantity and quality, dissatisfaction and possible contractual legal suits or cost adjustments. During the past three years, Island Creek Coal Company Management has given special attention and efforts to all phases of maintenance, starting with maintenance personnel training, central shop improvement, repair parts availability, equipment improvement--both overhaul and modification, and an overall maintenance system upgrading with concentrated emphasis on preventive maintenance.

34433 (CONF-7710111—, pp 204-208) **Moss No. 2 longwall move.** Bailes, C.M. (Clinchfield Coal Co., Lebanon, VA). 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

In Third symposium on underground mining.

Steps involved in moving longwall equipment from one panel to another are outlined. (LTN)

34434 (CONF-7710111—, pp 209-210) **Automation in mining.** Forney, R. (Ebasco Services Inc., Golden, CO). 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

In Third symposium on underground mining.

Target areas for automation are: Coal wining at the face; main and secondary haulage from face to surface; and preparation plant quantity and quality control.

34435 (CONF-7710111—, pp 211-230) **Monitoring and remote control progress towards automation in British coal mines, 1977.** Thomas, V.M.; Chandler, K.W. (National Coal Board, Burton-on-Trent, Eng.). 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

In Third symposium on underground mining.

After a significant rise in the 1960's, productivity has been stubbornly static for the last six years in spite of heavy investment in machines and plant with a high potential for improvement. Remote control can make a direct contribution to improved productivity in some cases by the elimination or reduction of manshifts involved in operating equipment. The automation of bunkers is a good example. However, a significant characteristic of poor performance more generally is the high incident of delays, breakdowns and lost working time. This applies not only at the face but also in the elsewhere-below-ground category especially in the field of transport of all types: mineral, men and materials. There is no easy solution to these problems--that is clear. A persistent attack on unreliability, higher standards of engineering and better control and organization of operations are important factors in any solution. The role of comprehensive monitoring in support of management in tackling these problems is examined. If productivity is the major concern, safety is of equal importance. Developments in environmental monitoring instruments and systems have been rapid during the lase few years. The major improvements are presented, and the continuing work outlined. The field of comprehensive monitoring and automation is one which borrows heavily from innovation elsewhere with microcircuit electronics and computers being the key technologies. The Board has pioneered a powerful minicomputer-based system for colliery applications. This has been given the name MINOS. This sytem is outlined and the facilities and opportunities it offers are described.

34436 (CONF-7710111—, pp 231-240) **Automating longwall processes.** Sharkey, A. (Bureau of Mines, Washington, DC). 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

In Third symposium on underground mining.

A considerable part of the Program effort is devoted to longwall mining and related activities and seeks to exploit longwall's known advantages over alternative mining systems; to removing constraints to its application where these can be identified and to further improve the production potential of the system by the development and application of advanced technology to the process. Among the many advantages of the longwall system is its relatively simple, repetitive production process which is conceptually capable of being adapted to a high level of remote control and possibly to automation. The automation of longwall processes offers a number of operational advantages which are detailed. Part of the funding of the program is therefore devoted to the development of means for achieving partial or total automation of the longwall mining systems. The degree of automation eventually achieved will be dictated by the cost-effectiveness of the developed technology in terms of its acceptance by the coal mining industry. To quantitatively measure the expected benefits from various system improvements, a model has been constructed of a longwall mine.

34437 (CONF-7710111—, pp 241-260) **Developments for automation in underground mining in Germany.** Olaf, J. (Bergbau-Forschung GmbH, Essen). 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

In Third symposium on underground mining.

Beyond the automation of individual operations, there is a need to ensure that all of these operations such as coal winning, road conveying and haulage, shaft winding and bundering smoothly match with one another, taking also into account certain aspects of underground environment, e.g. development and drainage of methane, mine temperature and mine climate, mine ventilation and energy supply. The purpose of optimizing all these operations is to arrive at a maximum working time of the coal wining equipment together with an optimum loading of coal without interruption of the means of conveying and haulage. The technical system required for accomplishing this task can only consist of an as comprehensive as possible monitoring of all the operational sectors and of a rapid systematic processing of the data obtained. To this end the use of both a process control computer as a master computer for the optimation of all operational sectors, as well as "mini"-or "micro-coputers" which are a kind of "satellites" collecting data and accomplishing specific control functions underground, will be indispensible. An efficient data transmitting system is the necessary link between these underground substations or satellites and the master computer at the surface. The great number of data, information, and measureed values to be transmitted from underground has initiated some time ago a wide use of cable-saving transmission techniques. In view of practical requirements the mining companies have preferred the audio frequency multiplexing technique for this purpose.

34438 (CONF-7710111—, pp 262-268) **Entry layout for longwall top slicing of thick coal seams.** Dunham, R.K. (D'Appolonia Consulting Engineers, Inc., Denver); Wisecarver, D.O.; Ellison, R.D. 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

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The main objective of the investigation was to develop an entry system to extract coal seams up to 100 feet thick by the longwall top slicing method. The very thick seam condition provides the opportunity for many possible basic mining arrangements when compared to alternatives availabe for single slice operations. On the other hand, the thick seam adds considerable complexity that places severe constraints on some important planning factors. A major part of the study was to devellop the rationale for the selection of the best candidate entry system for this new and complex condition. Many alternative combinations of entries and their subsystems were evaluated. The paper discusses alternatives considered and selected systems for: Panel sequencing, mining methods and equipment, materials handling, ventilation, and spontaneous heating control. Detailed economic analyses show small but significant increases in the mining cost when compared to conventional thin seam mining. However, economic feasibility of the method in the foreseeable future is apparent. Lowest costs will be realized by mechanizing the more labor-intensive aspects of mining the thick coal.

34439 (CONF-7710111—, pp 269-280) **Shortwall and room-and-pillar mining costs.** Green, L.E.; Palowitch, E.R. (Pittsburgh Mining and Safety Research Center). 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

In Third symposium on underground mining.

Experience gained during this demonstration supports the following conclusions: The shortwall unit produced 70 tons of raw coal per day more than an adjacent room-and-pillar unit operating under essentially identical conditions. The estimated direct cost of mining a ton of raw coal by the shortwall method is 18 cents higher than the cost of mining by the room-and-pillar method. The increased cost of depreciating the shortwall roof support system was only partially offset by reductions in the cost of supplies and materials. The profitability of a system that produces an additional 70 tons of coal per day but at an 18-cent-per-ton higher direct cost is a function of the direct operating costs, the fixed and variable indirect costs, the quality of the raw coal, and the selling price of the clean coal. Shortwall mining has been proven a viable alternative to room-and-pillar mining.

34440 (CONF-7710111—, pp 281-296) **Novel approach to longwall mining.** Hargraves, A.J. (Broken Hill Proprietary Co. Ltd., Wollongong, Australia). 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

In Third symposium on underground mining.

With the progressively increasing depth of mining operations in Australia, and with increasing problems with room and pillar mining, consideration of the alternative of longwall has resulted in a number of self advancing retreating longwalls and shortwalls in the N.S.W. mining areas, with some successes and some failures. Even with drivage at depth being thus minimized, problems are still experienced in keeping sufficient development ahead of extraction, with consequent hold-up of extraction schedules. The development of the shortwall method using trackless equipment and self advancing supports as an alternative to pillar extraction has generally met with success and has reduced drivages and improved recovery. If shortwall extraction can be done on the advance using existing mining equipment it could provide roadways for subsequent retreating longwalls or shortwalls and thus obviate drivage completely in areas destined for extraction. The particular problems in such a system lie in support of roadways during the advance stage and the retreating stage. There is promise in modern pack building methods of obviating the tedious chock building or pack building of the past and a the same time of providing effective seals against air leakages through goaves during advance work. In the case of certain Australian areas where outbursts of coal and gas occur in development the change to development by shortwall advancing should reduce the proneness one category and should thereby reduce the extent of preventive measures. The slower rate of advance of the "development" front, yet with perhaps augmented tonnage, should be a further factor in reducing proness. So far the method remains as a proposal and has not been tested.

34441 (CONF-7710111—, pp 297-311) **Modernization and modification of longwall systems at Island Creek Coal Company.** Curry, J.J. Jr.; Herron, R. (Island Creek Coal Co., Keen Mountain, VA). 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

In Third symposium on underground mining.

The main things that we have done to improve and modernize our original and existing longwall faces are better design in the following: Roof support, hydraulic systems, crusher, chain conveyance systems, power and controls, communications, plow, motor and speed reducer, dust allaying, belts and their related hardware. The improvement in any longwall system will depend to a large extent on mining people specifying what they want and having it custom designed to suit their needs and conditions. Looking to the future, we will be seriously considering such things as shield supports, automated hydraulic systems, such as the back push methods, and taking advantage of electronic know-how in areas such as remote controls and wireless communication systems.

34442 (CONF-7710111—, pp 312-359) **Longwall mining the Herrin No. 6 coalbed in southern Illinois.** Curth, E.A. (Pittsburgh Mining and Safety Research Center); Cavinder, M.D. 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

In Third symposium on underground mining.

In April, 1975, the Bureau of Mines awarded a cost-sharing contract to Old Ben Coal Co. with the objective of demonstrating that the Herrin No. 6 coalbed in southern Illinois can be mined by longwall methods using shield-type roof supports. Earlier attempts at longwalling using chocks ended in failure. A minimum of three longwall panels will be mined at mine No. 24. A premining investigation conducted by Dames and Moore laid the groundwork for mine design and equipment selection. Roof shields of the lemniscate type were chosen to control hazardous ground. The Bureau funded procurement of the roof support system, and Old Ben contributed the other longwall equipment. A ground control program included underground and subsurface instrumentation, a surface subsidence survey, and geologic mapping. Longwall face 1 started operation on September 3, 1976, after intensive training of crews and supervisors. The major adverse condition during the course of the panel extraction was the occurrence of limestone concretions called coalballs in massive pods, which slowed the face advance and damaged the shearer and other equipment. The shields maintained adequate roof control even in faulty ground. The panel came to completion on May 7, 1977, when the face holed through into the recovery room. After the very heavy and bulky equipment was recovered and transferred to the next panel, face 2 produced coal on August 1, 197

34443 (CONF-7710111—, pp 360-367) **Westmoreland Coal Company's approach to mine illumination.** Slone, R.E. (Westmoreland Coal Co., Big Stone Gap, VA). 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

In Third symposium on underground mining.

We have installed lighting systems on three continuous miners in our shop and lighting systems on a continuous miner and a roof bolter underground. The systems installed underground require 2 to 3 times more labor than those done in our shop. Those systems installed in our shop were far superior to those installed underground in terms of protecting wiring, power supply and luminaires. Based on these preliminary failure experience an operator's replacement and maintenance costs could be 100% of the installation costs yearly. Operating costs such as these could become staggering. It is readily evident to any person with practical knowledge of modern-day coal mining that the task of providing the required levels of illumination is not an easy one. Retrofitting many of the existing machines with permissible lighting will require custom installations. Special illumination systems will be required for certain types of mining. It is a physical impossibility to have all Westmoreland's machines on all 100 working sections equipped with lighting systems by the required date of April 1, 1978, but we feel we will be able to get all of the lighting systems designed and approved within the required time. The task of achieving these goals requires a concerted effort, but utilization of our illumination laboratory, we feel, gives us a better chance of meeting compliance.

34444 (CONF-7710111—, pp 368-377) **Illumination experiences at Pennsylvania Mines Corporation.** Kreutzberger, J. (Pennsylvania Mines Corp., Ebensburg). 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

In Third symposium on underground mining.

At the inception of the proposed illumination regulations, an illuminating Committee consisting of personnel from the Safety, Maintenance, and Electrical Departments was formed to decide on a standard system of illumination compatible with all of the Corporation mines. The results of this Illuminating Committee's indepth study indicated that at this time there are two ways of illuminating a working section and complying with Section 31-7(e) of the Coal Mine Health and Safety Act of 1969 and 75.1719 of the regulations: Area Lighting or Machine-Mounted Lighting. Area lighting does not appear to be appealing in continuous mining sections. Machine-mounted lighting involves mounting the luminaires on the mining sections makes the lighting as mobile as the machine. No additional personnel would be required to maintain the luminaires to fulfill the requirements of the law regarding luminaire positions. It was decided to approach the problem by following the concept of machine-

mounted lighting because of the following reasons: Area lighting systems are more cumbersome, requre additional stationary equipment, require additional cabling in the face area, and restricts the movement of mobile face equipment. The machine-mounted lighting developed for use at the time of the study was: Complete fluorescent, complete mercury vapor, complete sodium vapor, or a combination of any two. In order to obtain experience with the different types of hardware and fixtures available, it was decided to acquire a system of each type for test and evaluation. Therefore, testing was instituted on five five types of mining equipment. Design installation and testing criteria are outlined. (LTN)

34445 (CONF-7710111—, pp 378-383) **Results of Consol's ongoing program on mine illumination.** Patts, L.D. (Consolidation Coal Co., McMurray, PA). 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

In Third symposium on underground mining.

Consol's underground field testing of face illumination hardware has demonstrated that the required 0.06 foot-lambert (fl) reflected light level is a convenient guideline as a starting point for face illumination. To illuminate every 4 sr. ft. area to the 0.06 fL level is often impossible without locating luminaires in positions totally unacceptable to machine operators or top vulnerable to damage. Severe light overkill is also realized in the majority of instances when attempting to achieve 0.06 fL on every 4 sq. ft. area of the face. We have determined through practical experience that the following areas need not be illuminated to 0.06 fL for personnel to work safely: The area of roof directly above the machine operator's canopy; the are of rib and bottom opposite the operator's side of the continuous miner alongside and inby the gathering head. If the above mentioned coal surface areas were not required to be illuminated to the 0.06 fL level, face illumination could be achieved with less possibility of overkill and glare. Our experience indicates that more development and field work is necessary on mine illumination systems, and that MESA illumination requlations will have to be modified before it will be practical to install and satisfactorily maintain safe illumination systems. ZMine workers shouls not be subjected to the obvious safety hazards associated with glare, and they need not be reasonable modifications are made to existing illumination regulations. The application of face illumination must be done in a safe, workable manner hich will not detract from an operatort$s ability to work safety.

34446 (CONF-7710111—, pp 385-388) **BCR program in mine illumination.** du Breuil, F. (Bituminous Coal Research, Inc., Monroeville, PA). 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

In Third symposium on underground mining.

In December 1976 the mining research staff of Bituminous Coal Research, Inc., was asked by its Board of Directors to determine the present status of the federally legislated face machinery illumination program. With the deadline for compliance set for April 1, 1978, many BCR member companies were looking for guidance in planning the installation of lighting equipment in their mines. Suppliers were ready to sell hardware, but many prospective customers felt they did not have the knowledge required to make an intelligent choice. We have been in contact with coal operators, lighting equipment suppliers, and government agencies, each group concerned with a different aspect of mine illumination. We have found many people among these groups who are very knowledgeable, have good engineering sense, are open to new viewpoints, and willing to listen to and learn from each other in spite of their different affiliations and sometimes conflicting interests. From what we have seen we believe that increased illumination at the face is beneficial and possible. However, the technology is presently at the critical stage of expanding from a few demonstration units to widespread use of illumination; problems are bound to surface, whether in interpretation of the law, or reliability of the materials and designs used, or even in new hazards unwittingly introduced. We believe these problems can be solved if studied carefully and cooperatively by all concerned and no one adopts an "I know best" intransigent attitude. Our experience indicates there are capable people in all phases of the field of mine illumination who can reasonably resolve these problems if permitted to work together protected from outside, unqualified, self-serving pressures.

34447 (CONF-7710111—, pp 389-393) **Mine illumination.** Klouse, K. (Mining Enforcement and Safety Administration, Beckley, WV). 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

In Third symposium on underground mining.

The basis of MESA's regulations on mine illumination is the Federal Coal Mine Health and Safety Act of 1969. Compliance with the regulations will require a concentrated effort by the coal industry, manufacturers and MESA. MESA is offering services as follows: Technical assistance to coal mine operators and manufacturers. After testing lighting systems a Statement of Test and Evaluation of illumination systems that will be in compliance will be provided, and support functions (much as calibrating meters for illumination measurements). Certain specifications with respect to electrical safety are outlined briefly and inspection procedures with respect to compliance are discussed. (LTN)

34448 (CONF-7710111—, pp 394-400) **Bureau of Mines research program on mine illumination.** Bockosh, G.R. (Pittsburgh Mining and Safety Research Center). 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

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The Federal Coal Mine Health and Safety Act of 1969 provided for the formulation standards for underground coal mines; such standards were promulgated on October 1, 1976. The Bureau's program of research on mine illumination, which has evolved supportive data for standards and the technology necessary for their implementation, is presently directed toward demonstrating cost effective and reliable means to provide underground illumination, providing the technological means by which tese standards can be expeditiously realized, and insuring that the industry is aware of existing hardware and also possesses the expertise needed to apply it efficiently. The realization of a thoroughly informed industry and the existence of readily available, mineworthy hardware will enable the implementation of the standards to progress in a reasonable manner. The current work of the Bureau of Mines on mine illumination is described.

34449 (CONF-7710111—, pp 401-414) **Factory integration of an illumination system into a continuous mining machine.** Corbitt, S.W. 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

In Third symposium on underground mining.

The experience gained so far through NMSC work on illumination, for the most part, centers around light levels both required and desired. All light systems will have to comply to the MESA requirements, but for better customer acceptance, more light should be concentrated on the face or, in the case of other underground mining equipment, the area being worked. Also, the overall illumination requirement could be reviewed as to the possibility of reducing the required light level on the roof and rear ribs. In this same area, an allowable percentage of low level areas could considerably reduce design and cost of lighting systems. Second, only in importance to light level, is light fixture protection. The guards provided by light manufacturers are in general not heavy enough for continuous miner applications and basically any fixture that extends beyond the profile of the machine is in danger of either being crushed or sheared-off by falling or sliding rocks. Another conclusions was the advantages of incandescent headlights over the mercury-vapor type to the point of dropping the mercury-vapor from consideration on our lighting system. This is because of the extra cost and space requirements of the ballast needed for the mercury-vapors, and the surprisingly satisfactory light envelope of the incandescent. One final conclusion is the fact that the lights will have to be kept clean in order to stay in compliance with the requirements.

34450 (CONF-7710111—, pp 415-416) **USBM-sponsored mine illumination project at Bituminous Coal Research, Inc.** Whitehead, K.L. (Bituminous Coal Research, Inc., Monroeville, PA). 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

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The illumination program at Bituminous Coal Research, Inc., includes a project BCR-sponsored project, discussed in an earlier session by Dr. Felix du Breuil, and a second one includes a project funded by the U.S. Bureau of Mines designed to provide a means by which industry personnel may obtain information to assist them in specifying and maintaining illumination systems. This project includes three tasks: (1) the consolidation, mainenance, and distribution of MESA-evaluated mine illumination specifications; (2) the development and presentation of illumination training sesssions; and (3) the determination of installation costs associated with mine lighting systems.

34451 (DOE/ET—0033/1(78)) **Coal mining and preparation research, development, and demonstration in fiscal year 1978.** (Department of Energy, Washington, D.C. (USA). Div. of Solid Fuels Mining and Preparation). Feb 1978. 22p. Dep. NTIS, PC A02/MF A01.

This publication summarizes, for potential contractors and other interested parties, the proposed research, development, and demonstration contract projects programmed by the Department of Energy for fiscal year 1978 (October 1, 1977-September 30, 1978) under its Coal Mining and Preparation Research, Development and Demonstration Activity. The objective of these projects is to provide an ordered and sequenced series of advances toward the overall goal of providing the system technology required to assure the

availability of abundant supplies of coal at acceptable social and economic cost. It is the policy of the Department of Energy to utilize as fully as possible the capabilities of the private sector in mining and preparation research, and to that end this paper outlines the Department's present contract research needs to enable potential contractors to make decisions about participation in the program. Contracting for the Coal Mining and Preparation Research, Development and Demonstration Activity will be conducted in strict accordance with Federal Procurement Regulations.

34452 Toward the methods of thermal computation of deep mine walls in layer exploitation of the walls of thick coal seams and packing of the working space. Oniani, Sh.I.; Pirtskhalava, T.G. *Soobshch. Akad. Nauk Gruz. SSR;* **89**: No. 2, 417-420(Feb 1978). (In Russian).

A corrected expression has been obtained for computing the temperature factor of the walls, predicting the expected thermal conditions during exploitation of thick seams and controlling the roof with full packing in the working space.

34453 Gyroscopic effects in the performing members of narrow-clutch excavating coal combines. Bandzeladze, B.R. *Soobshch. Akad. Nauk Gruz. SSR;* **89**: No. 2, 141-143(Feb 1978). (In Russian).

The performing members of modern narrow-clutch excavating coal combines have been found to be stable to impacts. The transverse vibrations attending the operating conditions were found to cause vibrations on a new plane, holding a special place in respect to dynamic stress.

34454 Technology of mining of thin seams without strengthening the face space and without attendance of workers. Kratochvil, J.; Bobrek, J. (Vedeckovyzkumny Uhelny Ustav, Ostrava-Radvanice, Czech.). *Uhli;* **26**: No. 1, 3-9(Jan 1978). (In Czech).

The securing of the required output of coal mining, especially of coking coal, and the relative shortage of hard coal reserves in the CSSR necessitates the utilization also of coal reserves which have not been exploited until now on account of a low seam thickness, unsolved questions of a suitable mining technique and technology, or increased difficulties in excavating residual, protecting or tectonics-affected coal pillars. The authors of the article outline possibilities of a better management of the coal reserves in the CSSR through utilizing experiences and technical means used abroad in this field of mining activity.

34455 Full automation in British coal mining. Whitworth, K. *Bergbau;* **28**: No. 10, 406-407(Oct 1977). (In German).

In the 30 years since the nationalization of the British mining industry, mechanization has increased from 2.4 to 93.6%, the number of fatal casualties went down from its highest level of 476 in 1950 to 59 in 1975/76, and haulage per work shift rose from 1.1 t to almost 2.25 t. This article describes measures and technical developments which led to this success.

34456 Coal extraction: the mining engineer's dilemma. *Coal, Gold Base Miner. South. Afr.;* **25**: No. 8, 57, 59, 71(Aug 1977).

The problem of deciding mining method and the extent of mining in the case of 5 seams of different grades and minability and with the problem of limited market for low grade coal is addressed. A major part of the problem is the controlled price in South Africa of Grade A coal (with 12 percent more heat); only if the controlled price of Grade D were of the order of half the cost of grade A would it be feasible for companies to mine the low grade coal and be able to sell it at a profit rather than decide to leave it in the ground. Note that this requires a higher price for Grade A coal to the point that it is no longer economical for those who can use Grade D to demand the higher grade. (LTN)

34457 Some aspects of modeling rock fracture by the optical polarization method. Khesin, G.L.; Taratorin, B.I.; Sakharov, V.N.; Shavoronok, I.V.; Kuz'min, V.S.; Kutaeva, G.S.; Starchevskii, A.S. (V.V. Kuibyshev Moscow Engineering-Constructional Inst., Moscow). *Sov. Min. Sci. (Engl. Transl.);* **12**: No. 6, 580-584(1976).

Translated from Fiz.-Tekh. Probl. Razrab. Polezn. Iskop.; 12: 6, 23-28(1976).

The author's investigations show that it is possible to use the optical-polarization method to investigate the stresses in models of certain aspects of the process of rock fracture. The authors suggest a method of modeling the stresses in the neighborhood of stationary cracks in shear or transverse deformation, taking account of interaction between the flanks of the crack in the presence of friction; this permits investigation of a number of problems which have not been solved theoretically. They develop a method of modeling the process of crack propagation under tension. They show that the velocity varies discontinuously. They establish the conditions for branching of a crack. They show that the dynamic stress intensity coefficient depends on the velocity of the crack. They show that it is possible to use dynamic patterns of interference fringes to record the stress waves initiated at various moments during crack propagation during emergence at the free surface or interaction with various types of nonuniformity.

34458 Results of bench tests on the USD-2 dynamic flow. Lazutkin, A.G.; Ushakov, L.S.; Khamidulin, F.F.; Brenner, V.A.; Pavlov, Y.S.; Kurtagin, A.D.; Fedulov, A.I.; Labutin, V.N. (Inst. of Mining, Novosibirsk, USSR). *Sov. Min. Sci. (Engl. Transl.);* **12**: No. 6, 601-604(1976).

Translated from Fiz.-Tekh. Probl. Razrab. Polezn. Iskop.; 12: 6, 47-50(1976).

The productivity of coal-cutting machines can be increased and the quality indices of the cut coal improved by means of new, less energy-consuming methods of coal cutting. In certain conditions the percussive method of coal cutting satisfies these requirements. In this connection, increasing attention has recently been paid to finding or devising efficient designs for percussive effector units for dynamic plows. In the plans for attacking this problem, on the basis of combined investigations of cutting Karaganda coals by impulsive mechanical loads, the Giprouglegormash and Karaganda Polytechnic Institutes have together developed a design for an experimental dynamic plow, the USD-2, which was built by the Kargormash group. The USD-2 includes a cutting machine—the SD-1 dynamic plow with bilateral percussive effector unit—together with feed mechanism and face conveyer taken from the commercially produced USB-67 static plow. The USD-2 is intended for cutting coal from flat-lying seams 1.2 to 1.4 m thick with cutting resistances of up to 300 kgf/cm with individual or mechanized supports.

34459 Analysis of ventilation problems and means for solving them by network calculations involving computing techniques. Myasnikov, A.A.; Evstratenkov, G.S.; Tyurin, V.P. (Eastern Scientific-Research Inst., Kemerovo, USSR). *Sov. Min. Sci. (Engl. Transl.);* **12**: No. 6, 636-640(1976).

Translated from Fiz.-Tekh. Probl. Rzarab. Polezn. Iskop.; 12: 6, 86-91(1976).

There are no special difficulties in solving network ventilation problems with the aid of computing techniques. A large number of methods has been devised for solving them with computers and analog machines; these have often been surveyed in the Soviet literature and therefore we shall not discuss them here. We will describe the need for devising a new methodological approach for solving a special group of ventilation problems, and suggest a general method for solving them. If the ventilator fans or passive elements are incorrectly chosen, a situation may arise in which the aerodynamic conditions of one or more fans cross from the operational to the nonoperational branches of their characteristics. There is then a sharp depression of the fan. Such a situation is called unstable operation of the fans. It is regarded as an emergency, because in this case the ventilation conditions are ineffective and normal operation of the ventilator fans is impossible. If the characteristic of the ventilator fan is superimposed on the corresponding characteristic of the network, their points of intersection will determine the possible conditions of operation of the fan. If there is only one point of intersection, the conditions are single-valued, i.e., stable; if there are several points of intersection, then they are many-valued, and thus unstable. This is the only condition of stability. However, there can be various methods of verifying the satisfaction of this condition. There are two known methods of testing for stability: by plotting complete aerodynamic characteristics of the network at the points of installation of the ventilators, and by means of criteria of stability. We devise a new universal method of testing for stability in networks of any degree of complexity suitable for any method of computation. The principles of this method are described.

34460 Exact solution to the problem of inflow of gas into a borehole under conditions of quasilinear isothermal nonequilibrial filtration. Fedorov, A.V.; Gorbachev, A.I.; Somov, G.I. (Inst. of Mining, Novosibirsk, USSR). *Sov. Min. Sci. (Engl. Transl.);* **12**: No. 6, 640-644(1976).

Translated from Fiz.-Tekh. Probl. Rzarab. Polezn. Iskop.; 12: 6, 91-95(1976).

This communication gives an exact solution to the problem of inflow of gas into a bore-hole during nonequilibrial, isothermic filtration when the filtration coefficient depends on the state of stress in the solid rock.

34461 Determining the amount of gas emitted in a working during plane degassing of coal seams. Bondarenko, N.V. (Inst. of Applied Mineralogy and Metallurgy, Donetsk). *Sov. Min. Sci. (Engl. Transl.);* **12**: No. 6, 644-651(1976).

Translated from Fiz.-Tekh. Probl. Razrab. Polezn. Iskop.; 12: No. 6, 95-102(1976).

Gas emission in collieries during working of coal seams must be taken into account to ensure safety. Practical interest in assessing the amount of gas emitted into the worked-out area of coal seams has led to the publication of numerous reports on degassing of coal seams. Most of these reports examine schemes of one-dimensional gas filtration or give the results of experimental investigations. Certain plane problems of the theory of gas filtration in a coal seam are examined. To solve these problems Kochina used the method of conformal mapping, enabling one to construct a network of lines of the current and isobars in regions of gas movement. The use of a

computer made it possible to solve by this method the problem of plane degassing of coal seams for more complex regions reflecting real seam-working schemes. This communication examines certain plane problems of steady gas movement in coal seams being worked. For all the schemes investigated we assessed the amounts of gas emitted into the worked-out area.

34462 Calculating the economic effectiveness of degassing coal mines. Baev, K.A.; Evseev, I.I. (Scientific-Research Inst. for Safety in Mines, Makeevka, USSR). *Sov. Min. Sci. (Engl. Transl.);* **12**: No. 6, 651-654(1976).

Translated from Fiz.-Tekh. Probl. Razrab. Polezn. Iskop.; 12: No. 6, 103-105(1976).

Degassing of coal mines is finding increasing application as an effective method of reducing the gassiness of the workings, improving the safety of the mining operations, and increasing the output of the faces. In the USSR degassing is used in 150 pits, from which up to 2,000,000 m^3 of methane is drawn every day. With such a volume of collected methane, it is important to consider the most complete utilization of the methane as fuel. In order to extend the use of degassing, it is necessary to determine the economic effectiveness of degassing (both in use and at the planning stage) on account of the increased extraction of coal and utilization of the methane. The gain to the pit on account of degassing and utilization of the methane is 120,000 rubles per annum, of which 53,000 are due to the gain in coal output and 67,000 to the utilization of the methane.

34463 Mathematical model of low-temperature oxidation of a coal heap. Bonetskii, V.A.; Bogatyreva, A.S.; Egoshin, V.V. (Eastern Scientific-Research Inst., Kemerovo, USSR). *Sov. Min. Sci. (Engl. Transl.);* **12**: No. 6, 654-659(1976).

Translated from Fiz.-Tekh. Probl. Razrab. Polezn. Iskop.; 12: No. 6, 106-111(1976).

Present methods for predicting endogenous fires are insufficiently effective and planning organizations and coal enterprises do not have reliable methods for assessing fire hazard. Further perfection of measures for fire prevention requires a more accurate quantitative assessment of physical, technological, and ventilation parameters. A knowledge of the laws governing spontaneous combustion of coal in the worked-out area will enable us to investigate the influence exerted on it by individual factors and to regulate the temperature conditions by varying the quantitative values of these factors. Previous investigations of thermochemical processess of spontaneous combustion of coal concentrated on the evolution of heat at a constant rate of filtration of air within the reaction medium, no account being taken of convective removal or of the effect of diffusion of air on the change in the heat balance. The higher frequency of fires in thick steep seams is due to the fact that the coal left in the worked-out area is concentrated in crushed form in the lower sector of the panel. Our aim is to solve the problem of temperature determination along the horizontal axis in the center of a coal heap shaped like a parallelepiped in the presence of a predominant air current in the reacting medium of the caving zone along the strike of the seam. We assume ideal heat exchange with the ambient medium, the temperature of which is constant, and linear initial distribution from the oxygen concentration limits and air density. For a mathematical representation of processess of self-heating of coal with transition to combustion we selected the model of thermophysical processes in coking materials.

34464 Predicting productivities and capital equipment requirements using the PSU/USBM coal mine simulator. Manula, C.B.; Kenzy, G. pp 959-983 of World mining and metals technology. Volume II. Weiss, A. (ed.). New York; American Inst. of Mining, Metallurgical, and Petroleum Engineers, Inc. (1976).

From Proceedings of the joint MMIJ-AIME meeting; Denver, CO, USA (1 Sep 1976).

See CONF-7609165—P2.

A philosophy of dynamic modeling is introduced. The development of a simulation model of a coal mining system is described for the purposes of: (a) system design and selection of equipment for a new operation; (b) analysis of existing operations for possible alterations, additions, or general improvements.

TRANSPORT AND HANDLING

REFER ALSO TO CITATION(S) 34330, 34331, 34405, 34406, 34407, 34434, 34451, 34479, 34493

34465 (CONF-770652—, pp 237-244) **Laboratory investigation of the chemical comminution process: a method for the in situ fracturing of coal for gasification.** Datta, R.S. (Syracuse Research Corp., NY). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

Chemical comminution is a unique process in which the coal is selectively fragmented on exposure to ammonia. The fragmentation takes place along the maceral and mineral matter boundaries. The relationship between the physical properties of the coal, such as hardness, rank and moisture content, and the fragmentation rate have been presented. It is shown for a number of coals, that by the judicious manipulation of the reaction conditions such as chemical concentration, pressure, temperature and exposure time, the rate and extent of the fragmentation can be effectively controlled.

34466 (CONF-7710111—, pp 86-98) **Alternate means of transporting coal or waste rock.** Carstens, M.R.; Leva, D.W. (Georgia Inst. of Tech., Atlanta). 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

In Third symposium on underground mining.

Capsule pipelines are an alternate means of transporting coal or waste rock. Pneumatic capsule pipelines are transportation systems in which cargo is loaded into wheeled vehicles (capsules) with the capsules being pushed through a pipeline by flowing air. Small-diameter pneumatic capsule pipelines have been in use for over a century for movement of documents. Recent interest in large-diameter pneumatic capsule pipelines has been stimulated by the development of the technology for laying large-diameter steel pipelines and by societal demands for safer and less conspicuous transportation systems. The large-diameter pneumatic capsule pipeline is best suited for hauling particulate solids, such as coal, at a high flow rate on a nearly continuous basis. Two commercial systems of large-diameter pneumatic capsule pipelines are being marketed at the present time (1977)--one by the U.S.S.R. called "Transprogress" and one by a U.S. firm called "Tubexpress." Both systems use wheeled capsules coupled together into trains as cargo carriers. Development of the American system was begun at Georgia Tech in 1968. In 1970 a Houston-based firm signed a license agreement with the Georgia Tech Research Institute to develop and to market the system. A subsidiary firm, Tubexpress Systems, Inc., was formed to carry out the licensee's obligations.

34467 (CONF-7710113—) **Third symposium on coal preparation. NCA/BCR coal conference and Expo IV.** (National Coal Association, Washington, D.C. (USA); Bituminous Coal Research, Inc., Monroeville, Pa. (USA)). 1977. 286p. Dep. NTIS, PC A13/MF A01.

From 3. symposium on coal preparation; Louisville, KY, USA (18 Oct 1977).

The third Symposium on Coal preparation, sponsored by the National Coal Association and Bituminous Coal Research, Inc., was held at the Kentucky Fair and Exposition Center, Louisville, Kentucky, October 18-20, 1977. Fourteen papers from the proceedings have been entered individually into EDB and ERA; five additional papers had been entered previously from other sources. Topics covered involved chemical comminution and chemical desulfurization of coal (aimed at reducing sulfur sufficiently with some coals to meet air quality standards without flue gas desulfurization), coal cleaning concepts, removing coal fines and recycling wash water, comparative evaluation of coal preparation methods, coal refuse disposal without polluting the environment, spoil bank reprocessing, noise control in coal preparation plants, etc. (LTN)

34468 (CONF-7710113—, pp 22-31) **Chemical fragmentation of coal.** Datta, R.S. (Syracuse Research Corp., NY). 1977.

From 3. symposium on coal preparation; Louisville, KY, USA (18 Oct 1977).

In Third symposium on coal preparation.

Chemical comminution provides a unique way of fracturing coal. The coal is treated with a chemical (usually gaseous ammonia or aqueous ammonia, solution) under pressure, resulting in selective breakage which tends to occur along the bedding planes and along the mineral matter and maceral boundaries. This selective fragmentation liberates more mineral matter at a much coarser size than is possible with mechanical size reduction techniques. Because of the commercial significance of chemical comminution, fragmentation rate studies have been carried out to determine the effect of process conditions and coal properties so as to provide some insight into the mechanism of the process. Chemical fragmentation of coal is influenced by, among other conditions, parameters such as rank, moisture content, chemical, pressure and exposure time. Studies have been carried out to determine how these parameters affect the fragmentation rate.

34469 (CONF-7710113—, pp 32-73) **Materials for handling coal.** Koppi, W.A. (International Nickel Co., Inc., New York). 1977.

From 3. symposium on coal preparation; Louisville, KY, USA (18 Oct 1977).

In Third symposium on coal preparation.

It has been estimated that coal production in the United States will triple by the end of the century. Meeting this goal will require the best materials and equipment technology available. Proper material selection is vital in terms of energy conservation, product safety and equipment productivity. For best overall economy, it is essential

that materials selection be reviewed from the total cost-performance point of view and not based simply on initial cost. Materials for handling coal encounter a number of service conditions other than abrasion. These include corrosion, static loads, impact and fatigue stresses. Consistent properties are desirable so that materials will respond uniformly to manufacturing operations and give the field performance expected. The following discussion reviews pertinent characteristics of the abrasion resistant Ni-Hard irons, the corrosion resistant stainless steels, the high strength structural steels and the alloy machinery steels as related to design, fabrication and use. Ni-Hard is the name of a family of nickel—chromium white iron casting alloys that were developed for resistance to wear in rushing, grinding, milling and handling abrasive minerals and ores. While over 150 grades of stainless steel are being produced, three readily available grades are most used in industry today: Types 301, 304, and 316. The use of stainless steel for coal handling is growing rapidly because these alloys offer important benefits including: (1) corrosion resistance, (2) slideability and (3) high strength for lightweight structures.

34470 (CONF-7710113—, pp 74-83) **Enhancement of coal preparation plant production through the proper use of polymers.** Montgomery, C.T.; Beafore, F.J. (Dow Chemical U.S.A., Tulsa, OK). 1977.

From 3. symposium on coal preparation; Louisville, KY, USA (18 Oct 1977).

In Third symposium on coal preparation.

An extensive amount of laboratory and field work has been performed in the past 15 years showing that through the proper application of the appropriate polyelectrolyte to vacuum filtration and solids removal equipment the throughput in a coal preparation plant can be greatly increased and a higher quality product can result. Three main objectives are sought in order to improve thickener operation: The particle size of the fines must be increased so that rapid settling will occur according to Stoke's Law; all or most of the fines must be removed so that only clear water results; and the settled particles must be densified so that compact but fluid sludge mass results. Through the proper use of polymers it is possible to: (1) Reduce the loss of coal due to excess clays in the wash water. Field tests have shown that the cost benefit ratio of polymers used in the clarification equipment can be as high as $232 recovered to $1 spent. (2) Increase the production of vacuum filtration equipment. Field tests have shown that a 22 percent improvement on filter capacity can be achieved. (3) Decrease the moisture on fine coal being produced at the vacuum filter. Field tests have shown a 7.8 per cent moisture reduction in vacuum filter cake moisture. This saved 195,000 BTU's of drying energy per ton of fine coal.

34471 (CONF-7710113—, pp 84-95) **New concepts in fine coal cleaning.** Davis, J.J. (Davis Associates, Inc., McLean, VA). 1977.

From 3. symposium on coal preparation; Louisville, KY, USA (18 Oct 1977).

In Third symposium on coal preparation.

Coals are prepared by size reduction and subsequent particle sorting based upon particle size and density. The level of coal quality improvements attainable is variable, being constrained by processing objectives, cost, processing technology and coal characteristics. The extent to which a specific coal can be cleaned is dependent upon the characteristics of the coal and the sophistication of the preparation process. The limitations are often both economic and technical. The processes which will remove more pyrite from the coal necessarily utilize smaller particle sizes and are considerably more costly. The economic limitations of coal preparation are varied and numerous. Cleaning of coarse coal is relatively simple and less costly than cleaning of the finer sizes. The fine coal portion in the raw coal feed has materially increased as mechanization of mining process has increased, thus adding considerably to cleaning plant costs. Wet cleaning units for fine coal are not themselves expensive; it is the equipment necessary to dewater and dry the product that adds significantly to the cost. The disposal of waste refuse developed during the coal cleaning process represents an additional cost which must be attributed to the preparation plant. Energy consumed in coal preparation (grinding, drying, etc.) and intangible costs, such as accidents, must also be considered.

34472 (CONF-7710113—, pp 96-106) **Benefication of fine coal in the Republic of South Africa.** Fourie, P.J.F.; Erasmus, T.C. (Fuel Research Inst. of South Africa, Pretoria). 1977.

From 3. symposium on coal preparation; Louisville, KY, USA (18 Oct 1977).

In Third symposium on coal preparation.

The commissioning of the Institute's coal preparation pilot plant in 1957 marks the true birth of the technology in South Africa. The initial objective of the pilot plants was performance evaluation of a variety of units under local conditions. Since then, considerable experience has accumulated on the cleaning of large coal (+12 mm) and small coal (12 x 0.5 mm). Flotation cells were originally included to clean the shale medium for the Barvoys washer, now no longer in existence. It was not until 1960 that these were used in the cleaning of -0.5 mm coal. Attention has since also focused on other possible routes for upgrading -0.5 mm coal, viz., autogenous cyclones, tables, and dense medium cyclones. Of these, dense medium cyclones are considered the more promising and currently absorb the greater part of the research effort.

34473 (CONF-7710113—, pp 107-122) **MCCS: implementation at Homer City.** McGraw, R.W. (Pennsylvania Electric Co., Johnstown). 1977.

From 3. symposium on coal preparation; Louisville, KY, USA (18 Oct 1977).

In Third symposium on coal preparation.

An advanced coal preparation facility is currently under constructon near the Homer City Generating Station Power Complex, Homer City, Pennsylvania. The coal preparation facility will process 5,200,000 tons of ROM coal per year, and has a design capability of processing 1,200 TPH. The facility will produce (1) a medium ash, medium sulfur coal for utilization in the two (2) existing 600 MW Units at the Homer City Power Plant that will meet existing federal and state emission regulations of 4.0 lbs $SO_2/10^6$ Btu, (2) a low ash, low sulfur coal to be utilized in the new 650 MW Unit No. 3 currently under construction that will meet the new EPA emission regulation for new source emissions of 1.2 lbs $SO_2/10^6$ Btu without stack gas scrubbing, and (3) a high ash, a high sulfur refuse product, that will be deposited in a refuse area approximately one mile north of the preparation plant. The final preparation plant design was determined by extensive 96 part float-sink washability tests performed on the existing mining reserves that service the power plant. The data shows that a rigorously designed preparation plant operating at low gravity with the proper size range could produce adequate quantities of low sulfur fuel from these reserves. The MCCS facility will provide a cost effective method of controlling sulfur emissions from the new generating Unit No. 3 without the use of a flue gas desulfurization system. The facility has the design flexibility to operate two process circuits, independent from one another to achieve the optimum availability needed to supply coal to the Homer City generating units. The products from the facility can be directly conveyed over existing and new power plant conveying systems without the added cost of transportation.

34474 (CONF-7710113—, pp 123-136) **Pneumatic cleaning of fine coal for sulfur reduction.** Llewellyn, R.L. (Roberts and Schaefer Co., Pittsburgh). 1977.

From 3. symposium on coal preparation; Louisville, KY, USA (18 Oct 1977).

In Third symposium on coal preparation.

Pneumatic cleaning with Super Airflow units is a proven method available for the reduction of sulfur in the coal. It has an application which should be given serious consideration and if properly applied on certain coals, can meet the industry's requirements without highly sophisticated techniques which are costly to build, maintain and operate. The ash and sulfur content of the coal is reduced and the calorific value increased correspondingly.

34475 (CONF-7710113—, pp 137-140) **Feeding 3/8 x 0 coal to heavy medium cyclone.** Baumgartner, E. (Childress Corp., Beckley, WV); Campoy, J. 1977.

From 3. symposium on coal preparation; Louisville, KY, USA (18 Oct 1977).

In Third symposium on coal preparation.

Based on the demonstrated performance of a 100 ton per hour heavy medium cyclone plant, it is concluded that: without a desliming circuit, it is feasible and practical to feed $^3/_8$ x 0 raw coal to a heavy medium cyclone and to produce an acceptable clean coal product ($^3/_8$ x 100M); separations as low as 1.40 specific gravity have been demonstrated, using Grade B magnetite (90% minus 325M); operating records show magnetite loss has averaged 1.75 pounds per ton of raw coal feed; and with changes in the design criterions of conventional magnetite recovery circuits, and modifications to the standard medium control circuitry, the problem of fines contaminating the circulating medium has been overcome, thus, allowing proper specific gravity control.

34476 **Laboratory studies on the grindability of coal from the Kolubara, Pljevlja and Suvodol open-cast mines for selecting grinding plants for the 'Nikola Tesla' 305 MW, Pljevlja 200 MW, and Suvodol 200 MW thermal power plants.** Novakovic, L. *Braunkohle;* **29**: No. 10, 419-422(Oct 1977). (In German).

The influence of some important factors on the grindability of coal was investigated. These factors are 1) mineral content, 2) influence of origin and properties resp. of the petrographic composition, 3) influence of the characteristic features of open-cast mines, and 4) influence of the water content. The findings of these investigations influence the selection and operation of grinding plants when installing new thermal power plant units.

34477 **Washery efficiency and its financial implication.** Horsfall, D.W. *Coal, Gold Base Miner. South. Afr.;* **25**: No. 8, 125, 129, 131, 133, 135, 137, 139, 141, 143(Aug 1977).

Different methods of assessing washery efficiency parameters have been described. The importance of washery efficiency, in terms

of the Ep and Tromp Curve has been stressed, with particular reference to low ash coal separation. The use of performance data for simulating washing operations has been indicated; and the suggestion has been made that the washing plant of the future may well have a computerized model developed for it, by means of which actual performance can be compared with the practically attainable operating results.

COMBUSTION

REFER ALSO TO CITATION(S) 34404, 34463, 34899, 35864, 35866, 35872, 35875

34478 (ANL—78-7, pp 51-63) **Temperature control in the Exxon fluidized bed combustion miniplant.** Bertrand, R.R. (Exxon Research and Engineering Co., Linden, NJ). 1977.

From Symposium on instrumentation and control for fossil demonstration plants; Chicago, IL, USA (13 Jul 1977).

In Proceedings of the 1977 symposium on instrumentation and process control for fossil demonstration plants.

Exxon Research and Engineering Company, under contract to the EPA, has built and is operating a pressurized fluidized bed combustion unit which is capable of burning up to 218 kg/hr of coal (480 lb/hr). This unit is referred to as the Exxon fluidized bed combustion miniplant. One of the major systems on the miniplant is the control system used to maintain a uniform fluidized bed temperature. The method of bed temperature control, which is applicable to many coal conversion processes, is based on adjusting the rate of coal injected into the combustor. This presentation describes the temperature control system and the coal feed system. The performance of temperature control system and the associated coal feed system is also discussed.

34479 (ANL—78-7, pp 208-226) **Coal feeding and pneumatic transport.** Smith, R.D.; Phillips, K.E. (Combustion Power Co., Menlo Park, CA). 1977.

From Symposium on instrumentation and control for fossil demonstration plants; Chicago, IL, USA (13 Jul 1977).

In Proceedings of the 1977 symposium on instrumentation and process control for fossil demonstration plants.

The energy conversion process described, from coal crushing to generator output, is high amenable to computerized control as demonstrated in the 600 hours of coal-combustion tests in the 1MW PDU. The instrumentation and automatic control equipment permitted smooth transition between operational modes starting with the turbine operating on its own oil combustor and ending with steady-state operation on the coal-fired fluid-bed combustor. In continuous operation, bed temperature and turbine inlet gas temperature were maintained within +-10 F and +-4 F, respectively. Minor, short duration, feed supply upsets had virtually no effect on power output due to the high thermal capacitance of the hot-gas system. However, the inability to feed solids reliably from ambient conditions into the pressurized combustor resulted in major feed supply upsets and caused frequent test disruptions and shutdowns due primarily to feeder valve erosion from the coal and dolomite fines. Even though the problems of feedline erosion and plugging were solved during the PDU tests, the corrective actions of straight runs, dead ends, feedline redundancy, and screening of the crushed coal were expedients for a test program. A commercial plant feeding a similar solids mixture that is required to operate 8000 hours a year will require abrasive resistant transport piping, and expensive screening of the coal to prevent the entry of outsize foreign objects. A rugged dry-coal feeder is also required.

34480 (ANL/CEN/FE—77-7) **Evaluation of on-line light-scattering optical particle analyzers for measurements at high temperature and pressure.** Montagna, J.C.; Smith, G.W.; Teats, F.G.; Vogel, G.J.; Jonke, A.A. (Argonne National Lab., Ill. (USA)). Feb 1978. Contract W-31-109-ENG-38. 34p. Dep. NTIS, PC A03/MF A01.

Two light-scattering particle size analyzers have been tested at ANL in the process development unit (PDU) fluidized-bed combustion system. The analyzers are (1) a single-particle analyzer developed by Spectron Development Laboratory and (2) a multiparticle analyzer developed by Leeds and Northrup. Particle size distributions and mass loadings determined at different flue gas duct locations with the two instruments have been compared with those obtained with (1) an Andersen cascade impactor, (2) a Coulter counter, and (3) positive filters. These comparisons were used to evaluate the two instruments at their present state of development.

34481 (CONF-770652—, pp 229-236) **Simulated in situ combustion experiments.** Chaiken, R.F.; Harris, M.E.; Singer, J.M. (Pittsburgh Mining and Safety Research Center). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

As a first step in demonstrating the Bureau of Mines Process of in situ combustion of fossil fuels for thermal energy, simulated in situ burn experiments have been carried out in a 9.1-meter long fire tunnel containing approximately ¼ tons of coal and approximately 1 ton of oil shale. Data from these experiments will have input into the design of large trench burns (approximately 40 tons of fuel), which hopefully will lead to field tests in an underground coal seam. In the current study, Pittsburgh Seam coal and Anvil Point Oil Shale (44 gal/ton assay) were successfully burned for approximately 6 hours total duration utilizing an exhaust ventilation system to control the quality of the exhaust gas. Under steady operating conditions, exhaust temperature and thermal power levels were 800°C and 90 KW, respectively for coal, and 1000°C and 155 KW, respectively for oil shale. Fuel/Air ratios and gas compositions indicated near stoichiometric burning of the coal. SO_2 and NO/sub x/ pollutant levels were less than those from commercial pulverized coal combustors.

34482 (CONF-770652—, pp 253-263) **Combustion of bituminous coal in cracks in a rectangular combustor.** Douglas, G.W.; McKinley, M.D. (Univ. of Alabama, University). 1977.

From 3. annual underground coal conversion symposium; Fallen Leaf Lake, CA, USA (6 Jun 1977).

In Proceedings of the third annual underground coal conversion symposium.

Laboratory experiments on in-situ gasification of coal are being conducted in a rectangular-shaped laboratory combustor to simulate the underground process. Forward and reverse combustion runs have been made in cracks and in boreholes using bituminous coals from the Warrior coal field of Alabama. These coals are swelling coals which cause problems in gasification not found in lower rank coals. The objective of the experiments is to study the in-situ process for thin seams (18 to 36 inches thick) of bituminous coals to determine if the process warrants further field tests, and if so, how the tests should be conducted. The experiments to date have failed to produce a combustible product gas because of high oxygen concentration in the product gas. The basic mechanism for propagation of the reaction and char zones appears to be the same for both the forward and reverse combustion runs. The air velocities used were the same order of magnitude as those used in reverse linking in the Gorgas field tests, but the linking rate observed in the laboratory was an order of magnitude lower than observed in the field and than predicted theoretically. Heat losses from the reaction zone did not have significant effect on the results of the laboratory runs.

34483 (CONF-7710101—8) **Limestone SO_2 reactivity and causes for reactivity loss during multi cycle utilization.** Montagna, J.C.; Snyder, R.B.; Wilson, W.I.; Johnson, I.; Vogel, G.J. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 8p. Dep. NTIS, PC A02/MF A01.

From 5. national conference on energy and the environment; Cincinnati, OH, USA (31 Oct 1977).

The loss of limestone-SO_2 reactivity and capacity with increasing number of sulfation/regeneration cycles is caused by rapid limestone sintering (or possibly other internal structural changes) in the regenerator and not by a buildup of ash on the limestone surface. It is suggested that the presence of $CaSO_4$ in the limestone when exposed to the high temperature (1100°C) accelerates limestone sintering, causing a decrease in total porosity and thus a decrease in SO_2 reactivity. Four experimental results lead to this conclusion: (1) the regenerated limestone lost porosity with each succeeding cycle; (2) electron microprobe analyses of tenth cycle sulfated material suggesting that sintering had occurred; (3) tenth cycle regenerated dolomite when crushed had the same SO_2 reactivity as uncrushed dolomite, indicating that the ash shell was not limiting the reaction rate; and (4) high temperature treatment of partially sulfated virgin limestone causes a loss of SO_2 reactivity.

34484 (MERC/RI—78/1) **Fluidized-bed combustion test of low-quality fuels. I. Anthracite refuse.** Mei, J.S.; Gall, R.L.; Wilson, J.S. (Department of Energy, Morgantown, W.Va. (USA). Morgantown Energy Research Center). 10 May 1977. 56p. Dep. NTIS, PC A04/MF A01.

A total of five types of anthracite refuse material with widely different characteristics have been successfully burned in the 18-inch diameter atmospheric pressure fluidized-bed combustor at the Morgantown Energy Research Center of the Energy Research and Development Administration. Combustion characteristics of these anthracite refuse materials as well as engineering data were investigated for a wide range of operation conditions. Values of carbon combustion efficiency, sulfur dioxide and nitrogen oxides, heat transfer and heat release rates together with the analysis of ash content are presented. Results of this systematic study of the fluidized-bed combustion of anthracite refuse material indicate that a substantial amount of heating value contained in this rejected material can be recovered. This application of anthracite refuse, therefore, represents a potential source of energy for a region of the country which would benefit from such a new source to replace oil use which has increased with the decrease in anthracite coal mining.

34485 (SAND—78-8210) **Coal combustion research in Australia and New Zealand: a review of past and current research and a discussion of future research needs.** Hardesty, D.R. (Sandia Labs., Albuquerque, N.Mex. (USA); Sandia Labs., Livermore, Calif. (USA)). Mar 1978. Contract EY-76-C-04-0789. 87p. Dep. NTIS, PC A05/MF A01.

This report consists of a technical review of coal combustion research in Australia and New Zealand. It is based on information obtained during a visit to coal combustion research laboratories in these countries. The trip took place between October 1 and October 20, 1977 and was supported by the Power and Combustion Branch, Materials and Exploratory Research Division, ERDA/Fossil Energy (now Department of Energy/Division of Power Systems). A principal task under our contracted work for FY1978 consists of a technical assessment of research needs on the combustion of pulverized coals and alternative fuels derived from coal. This assessment project will document the experience and recommendations of experts in the United States and abroad, regarding research areas where DOE funding is likely to prove rewarding in terms of increased coal utilization. This information will also contribute to the effort of the Combustion Project Group of the International Energy Agency to define coal combustion research needs for member countries. This review includes a summary of previous and current research at fifteen institutions, as well as private recommendations for research directions by most of the Australian and New Zealand combustion scientists in the field. Some of the material has been obtained from the references noted in the bibliography. Copies of each publication noted in the bibliography may be obtained from the Combustion Sciences Department, Sandia Livermore.

34486 (TID—28327) **Pressurized fluidized-bed combustion component test and integration unit PFBC/CTIU project. ANL monthly progress report, November 1977.** Leffler, L. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 19p. NTIS, MF A01.

Portions of document are illegible.

The Industrial Users Review Group met at ANL. Their major recommendations was that the design pressure be increased from 12 atm to 16 atm. Impact of this change on cost and schedule is being evaluated. ANL and S-R material specialists are working together on the question of CTIU construction materials and devising a materials test plan. Issue 6 Process Flow Diagrams were reviewed and approved. The revised System Design Criteria documents for the Raw Material Storage Preparation and Handling System and the Combustor Feed Injection System were reviewed and approved. Rev. O design criteria documents for the Combustor Feed Injection, Pressurized Spent Solids, Atmospheric Spent Solids, Process Air Compression and Instrumentation and Control Systems were reviewed and approved. Process Vessel sketches for all combustor cases were reviewed. Two Site Configurations Meetings were held and Stearns-Roger now has all information needed to finish the G and A layouts and site interface drawings.

34487 **Fluidized-bed process for burning low-caloric fuels.** Raschka, A. *Aufbereit.-Tech.;* **18**: No. 10, 543-548(Oct 1977). (In German).

The paper highlights the characteristics of fluidized bed firing systems for burning fuels. Moreover, it furnishes proof that the fluidized-bed process is an optimum method for burning low-caloric fuels, especially those containing great amounts of water and ash. Seen from the point of view of process engineering, fuel of any water content can be fed into the furnace. The paper comments on the importance of the water content with regard to the efficiency of the firing system and autogenous combustion. An example comparing the cost of heat from a coal-fired boiler with that of a fluidized bed incinerator with low-caloric fuel evidences the economic advantages. The paper reports on a large-scale test where flotation tailings were burned in an industrial-scale fluidized-bed combustion system.

MARKETING AND ECONOMICS

34488 (TID—28339) **Effects of socioeconomic impacts on interregional allocations of potential increase in coal production.** Gilmore, J.S.; Moore, K.D.; Coddington, D.C. (Denver Research Inst., Colo. (USA); Bickert, Browne, Coddington and Associates, Inc., Denver, Colo. (USA)). Sep 1977. Contract EX-76-C-03-1379. 38p. Dep. NTIS, PC A03/MF A01.

It appears that negative socioeconomic impacts, or problems resulting from past impacts, offer a substantial potential for causing shortfalls in the 1985 coal production for the United States forecast by the National Energy Plan. The nature of significant impacts varies by coal producing region, and some regions appear more vulnerable to socioeconomic impact constraints than others. Furthermore, the effect of these impacts can be mitigated or avoided by a range of policies and actions available to federal and state governments, as well as the coal industry. The report defines and categorizes socioeconomic impacts. It then classifies the impacts to be found in the various coal producing regions as: Intractable constraints which appear to be major factors in realistically allocating incremental coal production goals; constraints which can be removed or externalities (external costs of additional coal development) which can be internalized; and residual constraints or externalities which can only be accepted, or avoided by reallocating incremental coal production among regions. The Central Appalachian conflict impacts presently appear to be the most likely intractable constraints during the 1977-1985 period. The Western conflict impacts may also be intractable. Both merit more intensive study, contingency planning for alternative sources of fuel, and continuous monitoring.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 34400, 34424, 34427, 34447, 34448, 34449, 34450, 34460, 34461, 34462, 34463

34489 (CONF-7710111—, pp 99-117) **Noise control of underground coal mining equipment.** Bartholomae, R.C.; Sacks, H.K. (Pittsburgh Mining and Safety Research Center). 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

In Third symposium on underground mining.

The development and demonstration of mining machinery noise control technology has been continued as mandated by the Federal Coal Mine Health and Safety Act of 1969. The present status of selected underground coal mine machinery noise research projects is summarized.

34490 (CONF-7710111—, pp 118-130) **Electronic monitoring and control of coal mine ventilation.** Aldridge, M.D. (West Virginia Univ., Morgantown). 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

In Third symposium on underground mining.

One of the key factors in the safe operation of any coal mine is a reliable and adequate ventilation system. Although ventilation networks can be subjected to detailed mathematical analysis and computer simulation, everyday operation of coal mine ventilation systems depends very little on such techniques but rather on experience and "cut-and-try"methods. While such methods have been adequate in the past, it is obvious that the ability to know the state of the total ventilation system at any given moment and to readjust flow distribution by remote control would be valuable from both safety and economic points of view.

34491 (CONF-7710111—, pp 131-147) **Systematic method of estimating the cost of injury-accidents in underground coal mining.** Boyd, D.C. (Denver Mining Research Center); DiCanio, D.G. 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

In Third symposium on underground mining.

It is hoped that the cost indicators generated by the U.S. Bureau of Mines Accident Cost Indicator Model will serve to accelerate and expand the efforts of industry, government, and coal miners to work toward safer extraction of coal. Most projections of the nation's future energy requirements point toward coal as an increasingly important energy source. This means incrased annual production and, with the continuance of present mining methods, increased exposure of coal miners to the hazards of underground coal mining. Perhaps the translation of the grim health and safety statistics of coal mine accidents into our society's prime yardstick--the dollar--will help us to achieve an energy future in which increasing utilization of our coal resources is achieved with decreasing waste of our human resources.

34492 (CONF-7710111—, pp 161-179) **Impact of deeper depths of cut on coal winning machines and respirable dust.** Black, S. (Fairchild Inc., Beckley, WV); Johnson, B.V.; Schmidt, R.L.; Banerjee, B. 1977.

From 3. symposium on underground mining; Louisville, KY, USA (18 Oct 1977).

In Third symposium on underground mining.

The Joanne Mine tests on the HH456 continuous mining machine were a significant undertaking by the Bureau of Mines. The results on airborne respirable dust and specific energy have provided strong evidence that invites industry to adopt lower rotational speed, deep cutting, continuous mining machines. Based on statistical analysis, the results show stepwise changes in airborne respirable dust and specific energy. No doubt future researchers will more fully develop relationships of amore continuous form as indicated by the multiple regression equations.

34493 (CONF-7710113—, pp 168-184) **Noise control of coal preparation plants.** Sacks, H.K. (Bureau of Mines, Pittsburgh); Rubin, M.N. 1977.

From 3. symposium on coal preparation; Louisville, KY, USA (18 Oct 1977).

In Third symposium on coal preparation.

An initial study of personnel noise exposure in preparation plants outlined problems and proposed general solutions. To demonstrate these principles, a complete source diagnosis was performed on a 1,650-tph preparation plant. Engineering controls were designed and implemented. The costs, maintenance problems, and long-term performance of these controls are documented on a representative variety of equipment. A substantial amount of work has already been done on identifying and characterizing the major noise sources in coal preparation plants. In addition, there has been increasing activity in the development and marketing of noise control materials for the mining and ore processing industries. What had been lacking was a compilation of quantitative data gathered in actual preparation plant environments on benefits and limitations of both the concepts and commercially available noise control materials. There was also a requirement for data on acoustical performance and costs of the noise control materials currently on the market. This project was designed to provide preparation plant operators with this type of information by documenting the benefits and problems derived from such noise control installations. This was done by selecting, installing, and monitoring a variety of noise control materials in an operating coal preparation plant.

REGULATIONS

REFER ALSO TO CITATION(S) 34410, 34424, 34444, 34445, 34447, 35386

34494 (CONF-7710112—, pp 5-24) **Regulation of the coal mining and preparation industry.** Rosenberg, J.I. (Mitre Corp., McLean, VA); Campbell, J.M.; Maneval, D.R. 1977.

From 7. symposium on coal mine drainage research; Louisville, KY, USA (18 Oct 1977).

In Seventh symposium on coal mine drainage.

This paper describes the existing relationship between coal mine and preparation plant operators and the regulators of such facilities at the state and Federal levels. By presenting examples of this relationship, drawn from a recent study, the paper has attempted to describe how the instruments of regulation (e.g., permits, licenses, and certificates) affect coal industry operators. Although we have not been able to quantify, in terms of exact time or dollars, the effect of such instruments upon the industry, it is certainly possible to conclude that the instruments themselves and their required use tend to limit the discretion of the operator. As operators' discretion is limited so is their ability to respond to changes in the market. Thus, it can be said that existing regulatory procedures which are required of the coal industry entail a certain degree of time delay which translates into additional administrative expense to the operator as well as lost marketing opportunities. Partly in recognition of this problem Congress provided a mechanism for state jurisdiction and control consistent with minimum Federal standards as established in the Surface Mining Control and Reclamation Act of 1977. This effectively reduces the potential for additional duplication of control in an area important to the coal industry. One primary area for consolidating Federal/state roles is in the design, construction and operation of coal refuse piles. Similar to the procedures soon to be employed for surface mines, MESA might be authorized to approve a particular state's requirements covering refuse piles which would avoid the current information repackaging and dual inspections. However, legislative modification must precede any such consolidation of regulatory practices.

PETROLEUM

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 34504, 34523, 34525

34495 **Comparison of crude oils and their alteration products.** Saxby, J.D. (CSIRO Minerals Research Labs., North Ryde, Australia). *Geochim. Cosmochim. Acta;* **42**: No. 2, 215-217(Feb 1978).

A simple method is proposed for using gas chromatographic data on the high molecular weight saturated fractions of crude oils to make comparisons of source materials, migration mechanisms and, in particular, alteration processes within reservoirs. The preferential loss of normal alkanes by bacterial attack on a light crude is one of several processes readily followed using this scheme.

34496 **Mapping stratigraphic traps with electrical transients.** Azad, J. (Electraflex Surv Ltd, Calgary, Alberta). *Bull. Can. Pet. Geol.;* **25**: No. 5, 995-1036(Sep 1977).

Electrical transients are used to obtain a reflection from hydrocarbon accumulations occurring in the subsurface. This information is used to plot the areal extent of pools in the subsurface and may provide a semiquantitative estimate of their magnitude. The method works irrespective of structure, making it ideally suited to deal with stratigraphic traps. To optimize the chances of commercial success, it should be integrated with all other sources of valid information; for instance, it complements seismic information by providing a direct hydrocarbon indicator. The use of the method in mapping stratigraphic traps is documented by a number of case histories.

DRILLING AND PRODUCTION

34497 (SAN—1396-1) **Caustic waterflooding demonstration project, Ranger Zone, Long Beach Unit, Wilmington Field, California. Annual report, October 1976—June 1977.** (Long Beach City Dept. of Oil Properties, Calif. (USA); THUMS Long Beach Co., Calif. (USA)). 1977. Contract EF-76-C-03-1396. 121p. Dep. NTIS, PC A06/MF A01.

A caustic-enhanced waterflooding pilot test is being initiated in the Ranger Reservoir of the Long Beach Unit, Wilmington Field, California, by the Department of Oil Properties of the City of Long Beach and the Field Contractor, THUMS, Long Beach Company in association with ERDA. A unique combination of two alkaline flood processes will be attempted for the first time to increase recovery efficiency. A 95-acre area, consisting of 11 producers bracketed by two 4-well injection rows and two major faults, has been selected for the pilot. During the initial phase of the project—which will be preceded by a period of softened salt water preflush—softened fresh water containing 0.1% by weight NaOH will be injected to emulsify the reservoir crude and improve conformance by the "emulsion entrapment" process. This phase will be followed by injection of 0.1% by weight NaOH in softened water containing 1.0% by weight NaCl to "entrain" the emulsified oil, hence to improve displacement efficiency. Preliminary site preparation, facilities design and installation work are nearing completion. Further laboratory investigation of the two caustic processes using native-state cores is continuing. A preliminary small-scale injectivity test of two-months' duration using the planned test chemicals was started in early June, 1977, in one of the pilot area injectors.

34498 (SAN—1396-3) **Improved secondary oil recovery by controlled water flooding-pilot demonstration Ranger Zone, Fault Block VII, Wilmington Field: Phase I. Quarterly report, October—December 1976.** (Long Beach, City of, Calif. (USA)). 19 Jan 1977. Contract EF-76-C-03-1396. 21p. Dep. NTIS, PC A02/MF A01.

The project is an improved waterflood demonstration of caustic water-flooding in a typical, well flood pattern of the Ranger Zone of the Long Beach Unit portion of the Wilmington Field. Two alkaline flood processes are to be used in this demonstration: caustic in softened fresh water is to be injected (entrapment process) to improve sweep efficiency, followed by caustic and salt (entrainment process) to improve flood displacement efficiency. The demonstration involves the input of 30,000 B/D water in 8 injection wells which surround 11 active producers in an area of 95 acres. Improved flood efficiency should occur as demonstrated by reduced water-oil-ratios and increased oil recovery. Surface and subsurface design work is progressing satisfactorily. The redrill, coring and special logging of one producer B-827A was completed and the well placed on production. Producing well B-712 was found to have a defective liner. Injector B-828-I was found to have a leaking shoe joint on the water string. Low temperature thermal stimulation of producing Well B-711 immediately adjacent to the pilot area was completed. Routine testing of cores from B-827-A was begun. The milestone chart for the project was revised in November, 1976. Approval of this change is being awaited. Expanded detail of the milestone chart with regard to the core testing and the mini-injection test were prepared. A map of the area and three performance plots are included.

34499 (TID—22787) **Availability and economics of CO_2 for enhanced oil recovery in Appalachia.** Pappano, A.W.; Sears, J.T.; Parr, W.R. (West Virginia Univ., Morgantown (USA). Dept. of Chemical Engineering). Aug 1976. Contract EY-77-G-21-8138. 42p. Dep. NTIS, PC A03/MF A01.

CO_2 sources are ammonia plants, gas wells located in southern West Virginia, and power plant flue gases. Literature regarding the application of CO_2 recovery systems to sour gases and ammonia production is quite extensive and published design information permits the selection of a number of well-developed processes. The application of conventional CO_2 separation systems to flue gases containing SO_2 is sparse. Additional research is necessary before power plant flue gases in Appalachia can be considered viable CO_2

sources. Estimates of CO_2 production costs from gas wells using the Benfield system ranged from $4.68 to $8.65 per ton of CO_2 produced, depending on the size and concentration of the wells considered, as indicated in the text. This is in contrast to the preliminary production cost of $13.00/ton CO_2 when a flue gas was used as the CO_2 source and a large solvent make-up was employed to account for solvent losses due to the presence of SO_2. These costs do not account for any transportation or pressurization required for the development of large-scale CO_2 floods, but by way of comparison commercial charges for delivered CO_2 in this region are in the neighborhood of $35-40/ton.

34500 Apparatus and method for well repair operations. Cooke, C.E. Jr. (to Exxon Production Research Co.). US Patent 4,074,756. 21 Feb 1978. Filed date 17 Jan 1977. 10p.

Flow channels behind the casing in a well are plugged by detecting a circumferential temperature anomaly on the casing, perforating in the direction of such anomaly, and introducing cement into the perforations. The apparatus for locating and perforating into a flow channel includes a sensitive temperature sensing assembly capable of detecting temperature differences as low as 0.01°F, and an attached perforating gun having a fixed orientation in relation to the temperature sensing assembly.

34501 Method of cementing well casing using a high temperature cement system. Gallus, J.P. (to Union Oil Co. of California). US Patent 4,069,870. 24 Jan 1978. Filed date 28 Jun 1976. 10p.

A high temperature cement system is described including a carbon-containing, low volatile material additive admixed with cement in proportions sufficient to provide a fixed carbon content of at least 0.02 wt. percent. Additives include anthracite, calcined coke, uncalcined coke, and burned oil shale.

34502 Well flow control apparatus and method. Davis, J.B.; Gant, G.W. (to Otis Engineering Corp.). US Patent 4,066,128. 3 Jan 1978. Filed date 14 Jul 1975. 12p.

A side-pocket mandrel for supporting a flow control device such as a gas lift valve along a well flow conductor and a method of operating same are described. The mandrel is connectible with pipe sections to form an integral length of a flow conductor and has a central bore communicating with the bore of the flow conductor, an orienting sleeve along an end portion of the mandrel, a side-pocket portion communicating with the main bore, a side-pocket landing nipple in the side pocket portion communicating with side ports in the mandrel along the landing nipple, a sliding sleeve valve disposed in the landing nipple for controlling communication through the side ports opening into the landing nipple, and a flow control device such as a gas lift valve releasably lockable in the sliding sleeve valve. The landing nipple and the sliding sleeve valve have locking recess and support and operating shoulder configurations whereby the sliding sleeve valve is moved to and locked at an open position when the flow control device is landed and locked in the landing nipple and the sliding sleeve valve is closed when the flow control device is removed from the landing nipple.

34503 Plugging permeable earth formation with wax. Cavin, D.C. (to Shell Oil Co.). US Patent 4,064,943. 27 Dec 1977. Filed date 6 Dec 1976. 10p.

The permeability within a subterranean earth formation can be reduced by depositing wax within the formation near its exposed face. A self-breaking aqueous cationic emulsion of wax is injected into the formation while the emulsion composition is such that wax particles are carried into the pores of the formation and then deposited.

34504 North Sea 77. State and prospects of exploration. Harms, K. *Oel;* **15**: No. 10, 272-281(Oct 1977). (In German).

A survey is presented of the state of development and the volume of production of petroleum and gas exploration in the North Sea. The individual drilling fields, in particular on English and Norwegian territory, are described, and questions of economics and costs in connection with the exploration are discussed.

34505 Crude production of wells with high water cut. Methods and their application. Werner, K. (Gewerkschaften Brigitta und Elwerath, Betriebsfuehrungsgesellschaft m.b.H., Hannover (Germany, F.R.)). *Erdoel-Erdgas Z.;* **93**: No. 9, 323-328(Sep 1977). (In German).

From DVGI spring meeting; Clausthal-Zellerfeld, Germany, F.R. (29 Apr 1977).

In the Federal Republic of Germany crude oil production is constantly increasing. In 1976 it reached 42 Mio m^3 at an average water cut of 85%. With regard to a large-scale crude oil production with a high water cut the four methods of artificial lift commonly used, which are sucker rod pump, submersible centrifugal pump, hydraulic pump and gaslift, are studied in view of their being dependent on well conditions, such as influx capacity, production medium, depth and diameter of production casing. The way in which these four types work is assumed to be well known. The necessity of controlling these methods in order to achieve forecast production and to extend the lifetime of the installations for improved economics is shown. The importance of a failure analysis and a lifetime survey of the artifical lift methods to achieve optimum operational planning is pointed out.

PROCESSING

REFER ALSO TO CITATION(S) 35455, 35457

34506 (ANL—78-7, pp 287-312) **Today and tomorrow in refinery control.** Hopkins, K.L. (Standard Oil Co., Cleveland). 1977.

From Symposium on instrumentation and control for fossil demonstration plants; Chicago, IL, USA (13 Jul 1977).

In Proceedings of the 1977 symposium on instrumentation and process control for fossil demonstration plants.

This paper describes the features of the control systems and instrumentation of a modern petroleum refinery. Illustrations are based on the Sohio-BP refinery at Marcus Hook, Pa., which was recently modernized. The paper also presents some projections into the future and a philosophical approach to solving existing problems and attaining better control for the future.

34507 Hydrocarbon fuel additive and process of improving hydrocarbon fuel combustion. Simmons, R.W. (to Ferrous Corp.). US Patent 4,073,626. 14 Feb 1978. Filed date 17 Dec 1975. 6p.

An improved liquid diesel fuel for diesel engines is made by incorporating at least 0.003% by weight of a mixture of an iron salt of an aromatic nitro acid and a nitroaliphatic compound having one to four carbon atoms, into the diesel fuel. The weight ratio of the aromatic nitro acid salt to the nitroaliphatic compound ranges from 1 : 10 to 1 : 100. The additive, when added to diesel fuel, (1) substantially eliminates hard carbon deposits from the valve and exhaust systems of diesel engines, thereby improving the efficiency of the engines and decreasing overhaul expense, (2) reduces air pollutants such as oxides of sulfur and nitrogen, and virtually eliminates carbon monoxide from diesel exhausts and (3) reduces or substantially eliminates slime deposits which form during diesel fuel storage.

34508 Process to separate hydrocarbons from gas streams. Ward, D.J. (to UOP Inc.). US Patent 4,072,604. 7 Feb 1978. Filed date 19 Jul 1976. 12p.

A process is described for the separation of specific C_2 to C_6 hydrocarbons from a gaseous feed stream containing C_1 to C_6-plus hydrocarbons. The feed stream enters an absorber and is first contacted by a primary lean liquid which is a portion of the bottoms product of the stripping column to which the rich absorber liquid is charged. The primary lean liquid contains the specific hydrocarbons which it is desired to separate from the feed stream. The feed stream is then contacted by a secondary lean liquid which does not contain these hydrocarbons and which is produced by fractionating a second portion of the stripper bottoms.

34509 Conversion of high-molecular-weight cyclic structures of feedstocks in hycrocracking by INKhS method. Katsobashvili, Y.R.; Nechaev, B.N. *Int. Chem. Eng.;* **18**: No. 1, 95-97(Jan 1978).

Translated from Neftepereab. Neftekhim.; 18: No. 12, 4-6(1975).

Low-pressure (30-atm) hydrocracking of a heavy aromatic coker gas oil or an asphaltite from deasphalting operations gives high conversions of the aromatic compounds. With the asphaltite feedstock, a 57% yield of liquid product is obtained, with 65 to 70% of the product distilling below 350°C.

34510 Relative contributions of hydrocarbons to formation of carbonaceous deposits on alumina/molybdenum and alumina/cobalt/molybdenum catalysts. Lipovich, V.G.; El'bert, E.I.; Lur'e, M.A.; Krestovnikova, L.R.; Vetlugina, L.N.; Kalechits, I.V. *Int. Chem. Eng.;* **18**: No. 1, 98-99(Jan 1978).

Translated from Neftepererab. Neftekhim.; 18: No. 12, 22-24(1975).

Relative coking tendencies of compounds present as impurities in coal-tar benzene and naphthalene cuts are determined by a radioactive tracer method.

34511 Resins and asphaltenes of coke deposits on alumina/cobalt/molybdenum hydrocracking catalyst. Brodskii, E.S.; Lukashenko, I.M.; Lebedevskaya, V.G. *Int. Chem. Eng.;* **18**: No. 1, 106-108(Jan 1978).

Translated from Neftepererab. Neftekhim.; 18: No. 2, 5-7(1975).

An investigation was conducted on the resin/asphaltene part of the coke deposits on fluorinated alumina/cobalt/molybdenum hydrocracking catalyst. Extracts from catalyst coke are analyzed by chemical methods, ir, and pyrolysis mass spectrometry to determine the molecular structure of resin and three asphaltene fractions.

34512 Effect of the molecular sieve separation of n-alkanes on the motor characteristics of the kerosene-gas-oil fractions of petroleum. Yaralov, B.S.; Tabakov, A.V.; Galich, P.N. *Int. Chem. Eng.;* **18**: No. 1, 139-140(Jan 1978).

Translated from Khim. Tekhnol.; 18: No. 1, 22-23(1976).

A pilot-plant study was performed of the cetane number, fractional composition, solidificatiion point and other parameters of the 200 to 250°C and 200 to 325°C fractions from a mixture of petroleum crudes before and after partial and complete removal of n-paraffins by adsorption on molecular sieves.

34513 Mathematical modelling of the high-temperature pyrolysis of gasoline. Chislovskii, V.V.; Karp, I.N.; Onis'kova, O.V.; Martsevoi, E.P. *Int. Chem. Eng.;* **18**: No. 1, 144-149(Jan 1978).

Translated from Khim. Tekhnol.; 18: No. 1, 14-18(1976).

A mathematical model and a computer program are described for simulating the high-temperature (2000 to 4000°K) pyrolysis of normal paraffins (C_4+) to produce acetylene as the primary product and calculation are presented. Kinetic model assumes the achievement of an intermediate nonequilibrium state followed by decomposition to the final pyrolysis products.

PRODUCTS AND BY-PRODUCTS

34514 Lube oil antioxidants based on metal complexes. Berenblyum, A.S.; Zadko, I.I.; Moiseev, I.I.; Trofimov, G.A.; Zaslavskii, Y.S.; Akchurina, E.Z. *Int. Chem. Eng.;* **18**: No. 1, 91-93(Jan 1978).

Translated from Neftepererab. Neftekhim.; 18: No. 11, 12-14(1975).

Cobalt chelates with organic bases are effective antioxidants in petroleum and synthetic ester oils at much lower concentrations than are required with conventional antioxidants.

MARKETING AND ECONOMICS

34515 Prospects for oil in the light of last decade's developments. Al-Saadi, A. *OAPEC News Bull.;* **4**: No. 2, 5-9(Feb 1978).

Conclusions are drawn regarding the probable production of oil from shale and tar sands and regarding the cost of this oil. The demands and supplies of oil in industralized nations are discussed. Future prospects for imported oil in industralized nations are discussed for the period until 1985 and for the period until 2000. All discussion is presented from OPEC point of view, and it is concluded that most of the increased energy demands of the industralized nations must be met by oil from OPEC countries.

34516 'Big ones' and their balance sheets. *Oel;* **15**: No. 11, 314-318(Nov 1977). (In German).

The balance sheets of the seven big petroleum corporations - Exxon, Royal Dutch/Shell, British Petroleum Co., Texaco Inc., Mobil Oil Corp., Gulf Oil Corp. and Standard Oil Co. of California - are discussed, and their decisions, activities and reactions on the basis of their annual reports of 1975 and 1976 are analyzed.

34517 Rotterdam's role in German oil supply. Kohlmorgen, T. (Esso A.G., Hamburg (Germany, F.R.)). *Oel;* **15**: No. 10, 284-287(Oct 1977). (In German).

The Rhine estuary houses the biggest concentration of refining and storage capacities in Western Europe. Its impact on the open German market, freely accessible to everyone, has frequently drawn severe criticism. Still, the economic interrelations also deserve some more favourable appreciation.

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 34514, 34660, 35488

34518 Analysis of 30 used motor oils. Cotton, F.O.; Whisman, M.L.; Goetzinger, J.W.; Reynolds, J.W. (ERDA, Bartlesville Energy Res Cent, Okla). *Hydrocarbon Process.;* **56**: No. 9, 131-140(Sep 1977).

In the reported experiments, samples of 30 waste lubricating oil feedstocks were obtained from 20 states within the continental United States. The oils were composites of crankcase drainings from automobiles for the most part. The composition of the petroleum base materials of these feedstocks was characterized by use of a chromatographic separation procedure to produce saturate, monoaromatic, diaromatic and polyaromatic-polar fractions. Saturate fractions were analyzed by mass spectral techniques. A comprehensive characterization of 5 oils selected from the 30 used oils of this study confirms the similarity of composition of feedstocks composited as described. The presence or absence of both major and minor compound types was generally consistent in these five oils as was the quantity of each. Extensive analytical data are tabulated and evaluated in terms of the effectiveness of reclaiming technology 12 refs.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 36017, 36018, 36019, 36020, 36021, 36022, 36108

34519 Hydrocarbons in surficial sediments from the Scotian shelf. Keizer, P.D.; Dale, J.; Gordon, D.C. (Bedford Inst. of Oceanography, Dartmouth, Canada). *Geochim. Cosmochim. Acta;* **42**: No. 2, 165-172(Feb 1978).

Surface sediments from 20 stations on the Scotian Shelf, collected on a transect from Halifax to Emerald Bank and around Sable Island, have been analyzed for hydrocarbon content and composition by gas chromatography and fluorescence spectrophotometry. Some samples were taken near abandoned exploratory drilling sites in the Sable Island area. Hydrocarbons appear to be mainly derived from biogenic terrestrial sources as evidenced by an inverse correlation of concentration with increasing distance from the mainland and a strong odd carbon preference in the n-alkanes. Contribution from petroleum sources, while minor, was most noticeable between Halifax and Emerald Bank. There is also evidence that the hydrocarbon composition at abandoned exploratory drilling sites has been slightly altered.

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 35856

34520 Cochin pipeline project. Hanna, B.W.; Bourbonnie, T.V. *Energy Process./Can.;* **70**: No. 3, 30-37(1978).

Traversing the provinces of Alberta and Saskatchewan, crossing the Canada-United States border in North Dakota and passing through North Dakota, Minnesota, Iowa, Illinois, Indiana, Ohio and Michigan, the 1,870 mile, 12-inch Cochin pipeline is only part of an Alberta-based $1.5 billion ethane-ethylene project.

PROPERTIES

REFER ALSO TO CITATION(S) 34495, 34702

34521 Calculation of phase equilibrium constants for petroleum cuts. Zhvanelskii, I.B.; Platonov, V.M. *Int. Chem. Eng.;* **18**: No. 1, 84-85(Jan 1978).

Translated from Neftepererab. Neftekhim.; 18: No. 10, 13-14(1975).

An equation is proposed for calculating phase equilibrium constants for petroleum cuts in terms of the constants for ethane and heptane and the volatility of the petroleum cut, and empirical equations are derived for determining each of these parameters.

34522 Behavior of ^{14}C-labelled methyl palmitate during alumina chromatography of petroleum hydrocarbons. Wickramasinghe, R.H. (Maryland Univ., Rollege Park (USA). Dept. of Chemistry); Mills, A.L.; Colwell, R.R. (Maryland Univ., College Park (USA). Dept. of Microbiology). *Naturwissenschaften;* **64**: No. 11, 584-585(Nov 1977).

34523 Composition and properties of Vendian and Cambrian oils on the Siberian platform. Drobot, D.I.; Presnova, R.N. *Int. Geol. Rev.;* **18**: No. 9, 1034-1042(Sep 1976).

Translated from Sov. Geol.; No. 6, 18-28(1975).

Combined geologic and geochemical processing and interpretation of the materials on old oils has revealed factors determining their composition and properties and established main directions of change in these properties. The basic and most common factors determining regional patterns of change in composition of Vendian and Cambrian oils are depth of subsidence of the rocks, degree of catagenetic transformation of organic matter, and lithofacies conditions of their occurrence. For the region's sedimentary mantle it is shown that supergene processes, differentiation within the oil pool, and vertical flow have played subordinate parts in forming the physicochemical properties of the oils.

STORAGE

34524 Effects on ground water caused by excavation of rock store caverns. Larsson, I.; Flexer, A.; Rosen, B. (R Inst of Technol, Stockholm, Swed). *Eng. Geol. (Amsterdam);* **11**: No. 4, 279-294(Dec 1977).

Unlined rock caverns for oil storage are very common in Sweden. Most of them are excavated in hard rocks (compact, non-carbonate, non-volcanic rocks). The fundamental idea of underground oil storage is that the rock caverns are located below the natural groundwater level. Thus the groundwater keeps the oil inside the caverns and prevents product migration. During the excavating period the water seeping through the fractures of a cavern is pumped up to avoid flooding. This discharge causes a local drop in the groundwater level around the cavern and a cone of depression develops. A local study of the development of such a cone of depression has been made by means of a network of observation holes around the cavern. On enlargement of an oil storage cavern (by constructing new caverns close to the old ones), the cone of depression moves according to the progress of the new excavations. This process has been studied and described in two cases. Underground storage caverns in Sweden are very often closely spaced in order to use common facilities such as entrance tunnel, pumping station, housing, etc. Therefore an artificial groundwater divide sometimes must be arranged between different caverns in order to prevent product migration. This paper describes how such an artificial recharge of water between some caverns is made. The control of its effectiveness is shown as well as the method for sealing off undesirable leakage. 3 refs.

COMBUSTION

REFER ALSO TO CITATION(S) 34699, 34907, 35867, 35871

NATURAL GAS

REFER ALSO TO CITATION(S) 35391

GEOLOGY AND EXPLORATION

REFER ALSO TO CITATION(S) 34496

34525 (NVO/0655—03) **Western Gas Sands Project. Quarterly basin activities report.** (CER Corp., Las Vegas, Nev. (USA)). 1 Jan 1978. Contract EY-76-C-08-0655. 37p. Dep. NTIS, PC A03/MF A01.

A summation of information is presented on geology and drilling activity in the four primary study areas of the Western Gas Sands Project. The areas of interest are the Greater Green River Basin, the Piceance Basin, the Uinta Basin, and the Northern Great Plains Province. Drilling activity is discussed for the months of October, November, and December, 1977, with the major emphasis on wells located in low permeability sandstone areas, having significant gas production and utilizing hydraulic fracturing treatments. The drilling information was obtained primarily from "The Rocky Mountain Region Report" published by Petroleum Information Corporation on a daily basis. Another source of information was the "Montana Oil and Gas Journal" which is released weekly.

34526 (NVO/0655—101) **Western gas sands project status report.** (Energy Research and Development Administration, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). 1 Nov 1977. Contract EY-76-C-08-0655. 58p. Dep. NTIS, PC A04/MF A01.

The Western Gas Sands Project Plan, Project Implementation Plans and Project Plan Document FY 78 are in various stages of preparation. Information gathering by U.S. Geological Survey (USGS) of the initial data base for many of the project activities is nearing completion. Some base maps are complete and field investigations in the principal areas of interest are being conducted. Research and development by Energy Research Centers and National Laboratories were directed toward new tools and instrumentation systems, rock mechanics experiments, mathematical modeling, and data analysis. The Uinta Basin in Utah and Piceance Basin in Colorado have ongoing massive hydraulic fracture (MHF) experiments in the Upper Cretaceous tight gas formations. These are: CER Corporation, MHF 3; Gas Producing Enterprises, Natural Buttes No. 14, 18, 19, 20; Mobil Oil, F-31-13G; and Rio Blanco Natural Gas, 498-4-1. Colorado Interstate Gas Company has been awarded a contract to determine if productivity in low permeability reservoirs can be improved by reducing the interstitialwater saturation. They will be using two wells, the Sprague No. 1 and Miller No. 1, completed in the Dakota J formation in the Wattenberg Field in north central Colorado. All of the massive hydraulic fracture wells, with the exception of the Pacific Transmission well, have been fractured as planned. The Mobil and GPE No. 14, 18, and 20 wells show significant improvement as compared to original flow rates. The Mobil well is being tested for additional MHF treatments. Sandia Laboratories is continuing their research program in hydraulic fracturing at DOE's Nevada Test Site (NTS).

34527 (NVO/0655—104) **Western Gas Sands Project. Status report.** (CER Corp., Las Vegas, Nev. (USA)). 1 Feb 1978. Contract EY-76-C-08-0655. 50p. Dep. NTIS, PC A03/MF A01.

The progress during December, 1977 of the major government sponsored endeavors undertaken to increase gas production from the low permeability gas sands of the western United States is summarized. The USGS is continuing geological and geophysical studies in the four major western basins to better characterize the resource base. Shipping arrangements for the core donated to the USGS by Inexco WASP (a well drilled for possible nuclear explosive stimulation in Wyoming) have been made, and cores for macrofossil and ostracode analysis from the Bowdoin Dome area have been collected. The National Laboratories, funded by DOE, are continuing their work in the area of research and development. The emphasis is on the development of new tools and instrumentation systems, rock mechanics, mathematical modeling and data analysis. Field tests and demonstrations active in the Uinta and Piceance Basins are Gas Producing Enterprises (GPE) Natural Buttes, Wells No. 14, 18, 19, 20, 21, and 22; Mobil Research and Development, Well No. F-31-13G; and Rio Blanco Natural Gas Company, Well No. 498-4-1. Colorado Interstate Gas Company has initiated activity on its project with the installation of equipment, and Mitchell Energy Company's proposal to conduct an MHF test in the Cotton Valley lime gas reservoir in Texas is nearing the contract negotiation stage.

34528 **Correlation of producing formations in the Sverdrup Basin.** Henao-Londono, D. (Panarctic Oils Ltd, Calgary, Alberta). *Bull. Can. Pet. Geol.;* **25**: No. 5, 969-980(Sep 1977).

By the end of 1976 six large and two small gas fields had been discovered in the Sverdrup Basin, with hydrocarbons contained in sands of six different formations. The correlation of these units with others in the basin is discussed. These correlations are based on stratigraphic, structural and paleontological data derived from subsurface information, and adhere closely to the standard nomenclature established by the Geological Survey of Canada. However, in some cases it was necessary to propose a redefinition of some names. 7 refs.

34529 **Consideration of clay in rocks in discriminating carbonate reservoirs in Eastern Turkmenia.** Ehivazov, A.M. *Neftegazov. Geol. Geofiz.;* No. 12, 6-9(1975). (In Russian).

A method is described for calculating the clayiness of rocks in discrimination of carbonate reservoirs of eastern Turkmenia. Carbonate deposits in eastern Turkmenia contain significant amounts of clayey material, which interferes with the collector properties of the rocks. However, in many cases the clayey limestones, when sampled, give industrial supplies of gas. Analysis of gamma-logging data with calculation of the results of sampling for layers of different porosities, as determined from the results of neutron gamma logging, showed a definite correlation between the reservoir properties of carbonate layers and the values of ΔIsub(γ) of two different gamma-logging parameters, calculated by the single "reference" horizon method.

DRILLING, PRODUCTION, AND PROCESSING

REFER ALSO TO CITATION(S) 34427

34530 **Ekofisk complex commissioned.** De Winton, C. *Gas World Gas J.;* **182**: No. 4708, 588-592(Nov 1977).

This article describes the startup of the undersea gas pipeline between the Ekofisk gas treatment center in the Norwegian sector of the North Sea and the Ems Estuary in northwestern Germany (East Friesland). Both the initial treatment at the offshore Ekofisk Center (mounted on the million-barrel reinforced concrete oil storage tank) and the subsequent treatment at the onshore gas treatment plant near Emden are briefly described. Some technical problems associated with the Ekofisk complex are also covered.

PRODUCTS AND BY-PRODUCTS

34531 **Garrington gas plant: expander in lieu of refrigeration.** Dyck, P.; Henderson, D. *Energy Process./Can.;* **70**: No. 3, 42-45(1978).

Operating history at the Dekalb Petroleum Garrington gas plant indicates the turbo expander to be a good alternative for refrigeration. Consideration must be given, however, to system requirements such as front-end compression, final sales gas pressure and potential plant expansion.

34532 Current natural gas liquid treating methods in Canada. Masson, W.B. (Dome Petroleum Ltd., Calgary, Alberta). *Energy Process./Can.;* **70**: No. 3, 46-50(1978).

Careful analysis of plant process and identification of sulphur compounds to be removed are required to select proper economical process or combination of processes if product is to meet G.P.A. specifications.

HEALTH AND SAFETY

34533 Potential risks of liquefied natural gas. Van Horn, A.J.; Wilson, R. (Harvard Univ., Cambridge, MA). *Energy (Oxford);* **2**: No. 4, 375-389(Dec 1977).

Imported liquefied natural gas can provide needed supplements to diminishing domestic gas supplies as well as being a convenient means for the storage and transportation of natural gas. LNG vessels and facilities are, however, costly and present the risk of potentially large accidents. We describe these risks and the impacts of LNG operations, summarize the safety issues, and make several policy recommendations for the responsible use of this premium fossil fuel.

MARKETING AND ECONOMICS

34534 (TID—28076) **National Gas Survey. Curtailment strategies.** (Curtailment Strategies Technical Advisory Committee (USA)). Mar 1977. 438p. Dep. NTIS, PC A19/MF A01.

Report to the Federal Power Commission. Portions of document are illegible.

This report sets forth to the Federal Power commission general schemes to govern the inevitable curtailments of natural gas necessitated by the great disparity between the current supply and demand. It states general objectives which must be achieved by any rational curtailment program and has analyzed various alternative strategies aimed at fulfilling those objectives. The Committee concluded that a strategy based upon (1) end-use principles of classification and (2) cost-of-conversion criteria for the assignment of relative priority to such end-uses best reconciles the inherently conflicting aims of market imitation and administrative feasibility, and best minimizes both resource costs and transaction costs. The Committee's conclusions are based on the assumption that gas curtailments will be required for a relatively prolonged period and at relatively deep levels, thus necessitating a plan which is sufficiently flexible to be adapted to changing circumstances and to serve as more than merely a stopgap function. The Committee's conclusions are also based on the assumption that the cooperation which currently exists among the nation's regulatory bodies (the Federal Power Commission and the various state commissions) will continue in a concerted effort to implement effective curtailment policies with regard to the entire natural gas market so that the natural gas shortage may be coped with in the most rational and responsible manner. The Committee in its work has identified three aspects of curtailment which it believes require immediate consideration: (1) attachments of new high priority service, (2) gas pooling and other gas supply options, and (3) the relationship between curtailments and increasing reliance on foreign oil.

ENVIRONMENTAL EFFECTS

REFER ALSO TO CITATION(S) 36014

ARTIFICIAL STIMULATION, PLOWSHARE, ETC.

REFER ALSO TO CITATION(S) 34526, 34527

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 34534, 35392

TRANSPORT, PIPELINES, AND HANDLING

REFER ALSO TO CITATION(S) 34530, 35804

34535 Arctic gas pipeline soon a reality. Pipeline construction in the Yukon Territory is expected to begin on January 1 of 1981, the culmination of a decade of northern gas pipeline R and D. Mirosh, E.A. (Foothills Pipe Lines (Yukon) Ltd., Calgary, Alberta). *Eng. J. (Montreal);* **61**: No. 1, 25-28(Jan 1978).

Research on northern natural gas pipelines showed the need to chill natural gas (below 32°F) totally in continuous and partially in discontinuous permafrost regions, to minimize frost heaving of pipe in unfrozen frost-susceptible soils, and to prevent unstable ductile crack propagation in the pipeline. Test facilities being planned for further studies (frost heave, burst) are described briefly. Pipeline construction in the Yorkon Territory is expected to begin Jan. 1, 1981. The Alaska Highway Project is also described. (DLC)

34536 New developments in the gas transportation network of France. Fort, R. (Gaz de Fr). *Rev. Energ.;* **28**: No. 297, 460-472(Oct 1977). (In French).

During the next few years, new developments are going to occur for the French natural gas transportation network. A study was made in particularly favorable conditions because instead of defining partial reinforcements for each new supply source, a global and optimum reinforcement was chosen for a number of major supply sources. At the same time, due to the decisions concerning the gas feeding of the Brittany region in northwest France, a precise definition of the canalizations to be built in this region was made. A very precise work program is now available and this favors good execution of the work projects and an improvement in costs. Maps of the French gas network and various new pipeline routes are given. Details on the various supplies are provided.

34537 Legal preconditions for the construction and operation of district gas mains. Joachim, H. *Energiewirtsch. Tagesfragen;* **27**: No. 6, 395-402(Jun 1977). (In German).

The course of procedure in connection with the construction of district gas mains is outlined. This includes acquisition of main rights under private law and expropriation law, special problems such as peculiarities of land or landscape, road crossings, facilities of the Federal railway, agriculture etc., operational problems such as protection zones, building territories within the area of the main layout, drainage effects, high-pressure pipes, etc.

34538 Aluminum as a material for liquid transportation. Kehler, W.F. *Schweiz. Alum. Rundsch.;* **27**: No. 4, 158-164(1977). (In German and French).

The article reviews some recent developments in the design and construction of cryogenic aluminum alloy containers for liquid natural gas tankers. 2 refs.

PROPERTIES

REFER ALSO TO CITATION(S) 34539

COMBUSTION

REFER ALSO TO CITATION(S) 34699, 34906, 35871

STORAGE

34539 Storage of natural gas dissolved under pressure in refrigerated liquified propane gas. Calculation suitable for microcomputer. II. Liquid-vapor equilibrium in a tank. Caffo, E.; Kaftal, A. (Stn Sper per i Combust, San Donato Milanese, Italy). *Riv. Combust.;* **31**: No. 7-8, 240-247(Jul-Aug 1977). (In Italian).

A program suitable for use with a microcomputer is proposed for calculating the liquid-vapor equilibrium of natural gas dissolved under pressure in refrigerated LPG stored in a tank. The equilibrium calculation uses the REDLICH-KWONG-SOAVE equation. The procedure starts from a convenient initialization of the composition of the vapor phase, from which a hypothetical composition of the entering gas is obtained. In successive approximations using linear interpolation, the composition of the vapor phase is modified to the point where the hypothetical composition of the entering gas comes close enough to the true composition. 11 refs.

OIL SHALES AND TAR SANDS

REFER ALSO TO CITATION(S) 34515

SITE GEOLOGY

REFER ALSO TO CITATION(S) 34541

DRILLING, FRACTURING, AND MINING

REFER ALSO TO CITATION(S) 34541

OIL PRODUCTION, RECOVERY, AND REFINING

REFER ALSO TO CITATION(S) 35856

IN SITU METHODS, TRUE AND MODIFIED

34540 Method and apparatus for retorting oil shale at subatmospheric pressure. Cha, C.Y.; Ridley, R.D.; Burton, R.S. III. (to Occidental Oil Shale, Inc.). US Patent 4,076,312. 28 Feb 1978. Filed date 30 Jul 1976. 8p.

In a process for retorting oil shale in a situ oil shale retort having a tunnel adjacent to retort, off gas is produced. Leakage of the off gas into the tunnel is prevented by withdrawing off gas from the retort at a rate sufficient to reduce the pressure in the retort adjacent the tunnel to a pressure below the ambient pressure within the tunnel.

34541 Unconventional oil. III. The Syncrude Project and the future of heavy oil development. Sande, W.N. (Suncrude Can Ltd, Edmonton, Alberta). *Rev. Energ.;* **28**: No. 296, 116-130(Aug-Sep 1977). (In French and English).

This article summarizes the history of the tar sands, describes the geology in general terms, describes the Syncrude Project (Canada) from its inception and portrays the magnitude of the Project explaining the problems associated with large-scale tar sand recovery programs. With this background, the future of tar sand development, both mining and in-situ, is discussed. The oil sands are present along a discontinuous northwest-southeast trend across northern Alberta from Peace River on the west, to Cold Lake on the east. Between these two are the largest deposit at Athabasca, the Wabasca area, and other small accumulations. A slightly less viscous oil is present in the Lloydminster area where oil is being recovered by conventional means, aided by stimulation methods. The Athabasca oil sands, with about 625 billion barrels of oil-in-place, is the largest heavy oil sands accumulation in the world. Altogether, the long-term production potential from al the tar sands is 300 billion barrels of recoverable oil.

PROPERTIES AND COMPOSITION

REFER ALSO TO CITATION(S) 34400, 34702

34542 Simulated geothermal maturation of Athabasca bitumen. George, A.E.; Banerjee, R.C.; Smiley, G.T.; Sawatzky, H. (Can Cent for Min and Energy Technol, Ottawa, Ont). *Bull. Can. Pet. Geol.;* **25**: No. 5, 1085-1096(Sep 1977).

Athabasca bitumen was subjected to thermal treatment of increasing severity under reducing conditions. The generation as well as the change in relative distributions of different components were followed and the resulting products were compared with other Cretaceous oils that lie in the Western Canada Tar Belt and have different degrees of maturity. Reductive thermal treatments converted the bitumen to materials similar to the more mature Cretaceous oils. The saturated hydrocarbons as well as the dinuclear aromatic fractions were of particular interest and were studied in detail. All the evidence obtained from this study indicates that the Athabasca bitumen is an immature material. 15 refs.

DIRECT USES AND BY-PRODUCTS

REFER ALSO TO CITATION(S) 34481

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 34400

MARKETING AND ECONOMICS

REFER ALSO TO CITATION(S) 35346

ENVIROMENTAL ASPECTS

REFER ALSO TO CITATION(S) 34660

NUCLEAR FUELS

34543 (GJO—108(77)) **Uranium industry seminar.** (Department of Energy, Grand Junction, Colo. (USA). Grand Junction Office). 1977. 293p. (CONF-7710121—). Dep. NTIS, PC A13/MF A01.

From Uranium industry seminar; Grand Junction, CO, USA (26 Oct 1977).

Papers were presented at the seminar on uranium enrichment, uranium market, resource evaluation, uranium exploration, uranium supply, and regulatory considerations. A separate abstract was prepared for each paper. (JRD)

RESERVES

REFER ALSO TO CITATION(S) 34562

34544 (GJO—108(77), pp 113-142) **Ore reserves.** Meehan, R.J. 1977.

From Uranium industry seminar; Grand Junction, CO, USA (26 Oct 1977).

In Uranium industry seminar.

The Grand Junction Office of the Department of Energy (DOE) maintains a comprehensive program of uranium resource and supply assessment. The nucleus of this program, from which the potential resource and supply evaluation efforts evolve, is the ore reserves program. A presentation is made to provide current information on (1) the distribution of domestic uranium ore reserves; (2) the newly introuced $50 per pound U_3O_8 reserves and the uranium mineral inventory; and (3) investigations to improve methodology of estimation. A case history of a deposit is given to illustrate DOE's reserve estimation procedures.

34545 (GJO—108(77), pp 143-158) **Potential resources.** Hetland, D.L.; Grundy, W.D. 1977.

From Uranium industry seminar; Grand Junction, CO, USA (26 Oct 1977).

In Uranium industry seminar.

The estimation of potential resources is a dynamic process and estimates may change considerably from year-to-year depending on the quantity and quality of available new geologic information. Therefore, a continuous process of re-evaluation of domestic uranium resources is necessary to take advantage of new data being generated by industry and by NURE program investigations in order to increase the reliability of the estimates of the Nation's uranium resources. A summary of the domestic uranium resources as of January 1, 1977, is presented along with the major changes that were made during 1976. Also the principles of estimating potential resources are discussed with an example of how potential was estimated for a portion of the San Juan Basin, New Mexico.

34546 Recognition of a new uranium province from the Precambrian of Sweden. Adamek, P.M.; Wilson, M.R. (Sveriges Geologiska Undersoekning, Stockholm). pp 199-214 of Recognition and evaluation of uraniferous areas. Proceedings of a technical committee meeting held in Vienna, 17-21 November 1975. Vienna; IAEA (1977).

From Technical committee meeting on recognition and evaluation of Uraniferous areas; Vienna, Austria (17 Nov 1975).

See CONF-7511132—.

The Arjeplog-Arvidsjaur uranium province, situated immediately south of the Arctic circle, comprises a group of mineralizations with a potential of over 10000 tonnes uranium. It occurs close to the margin of a Middle-Proterozoic continent. The individual mineralizations are associated with soda-metasomatism, have pitch-blende as dominant ore-mineral and have U-Pb dates in the range 1740-1850 m.y.

34547 Stages in ore deposition and classification of exogenic uranium deposits. Danchev, V.I.; Strelyanov, N.P. *Int. Geol. Rev.;* **20**: No. 1, 81-92(Jan 1978).

Translated from Geol. Rud. Mestorozhd.; 20: No. 3, 11-24(1976).

Various schemes for the classification of exogenic uranium deposits are mentioned, and some of their deficiencies are noted. Based on an analysis of data indicating the development of an ore-forming process during different phases and stages of lithogenesis, a variant of the genetic classification of uranium deposits in rocks of the sedimentary cover is proposed. The productivity of uranium ore formation during the process of sequentially developing phases and stages of lithogensis of sedimentary host rocks is discussed. 48 references are cited. (BLM)

34548 Some characteristics of the relation between uranium and the phosphate of nodular phosphorites of the Russian platform. Kozlov, A.A. *Int. Geol. Rev.;* **20**: No. 1, 93-95(Jan 1978).

Translated from Izv. Vyssh. Uchebn. Zaved., Geol. Razved.

The uranium distribution in the phosphate of marine nodular phosphorites of the central Russian Platform has been investigated by a radiographic method. The maximum uranium contents of amorphous phosphates, (40 to 50) x 10^{-4}%, were found at sites of greatest humic colloid concentration. (BLM)

34549 (LA-tr—78-17) **Fluid phases contemporaneous with the diagenesis of sandstones, tectonic movements and operation of the nuclear reactors of Oklo (Gabon Republic).** Openshaw, R.; Pagel, M.; Poty, B. (Los Alamos Scientific Lab., N.Mex. (USA)). 1978. Translation of French report. (CONF-771222—10). 41p. Dep. NTIS, PC A03/MF A01.

From IAEA symposium on natural fission reactors; Paris, France (19 Dec 1977).

The joint study of fluid inclusions and the petrography of the FA sandstones at Oklo allows an evaluation of the conditions of temperature and pressure of the various diageneses. It also allows for establishing in time the formation and operation of the natural reactors with respect to geological events. The conditions of the siliceous diagenesis, such as those of the formation of the tectonic structure of Oklo at its beginning, are evaluated at about 240°C and 1000 bars. The carbonation diagenesis, which is posterior to the operation of the natural reactors, probably occurred at about 180°C and 800 bars. During the nuclear reaction, the density of the fluids and the pressure stresses (between 1000 and 800 bars) suggest that the aqueous solutions probably were brought to temperatures between 450 and 600°C.

EXPLORATION

34550 (DPST—78-146-1) **Savannah River Laboratory hydrogeochemical and stream sediment reconnaissance. Preliminary raw data release, Charlotte 1° x 2° NTMS area, North Carolina and South Carolina. National Uranium Resource Evaluation Program.** Heffner, J.D.; Ferguson, R.B. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1978. Contract EY-76-C-09-0001. 231p. (GJBX—40(78)). NTIS, MF A01.

Portions of document are illegible.

This report presents preliminary results of stream sediment and ground water reconnaissance in the Charlotte National Topographic Map Series (NTMS) 1° x 2° quadrangle. Stream sediment samples were collected from small streams at 1254 sites for a nominal density of one site per 13 square kilometers (five square miles) in rural areas. Ground water samples were collected at 759 sites for a nominal density of one site per 25 square kilometers (ten squre miles). Neutron activation analysis (NAA) results are given for uranium and 16 other elements in sediments, and for uranium and 9 other elements in ground water. Field measurements and observations are reported for each site. Analytical data and field measurements are presented in tables and maps. Statistical summaries of data and a brief description of results are given. A generalized geologic map and a summary of the geology of the area are included. Key data are presented in page-sized hard copy. Supplementary data are on microfiche. Key data from stream sites include (1) water quality measurements (pH, conductivity, and alkalinity), (2) elements that may be related to potential uranium and thorium mineralization in this area (U, Th, Hf, Ce, and Dy), and (3) elements useful for geologic classification of the sample area (Ti, V, Fe, Mn, Al, and Sc). Supplementary data from stream sites include sample site descriptors (stream characteristics, vegetation, stream width, etc.) and additional elemental analyses that may be useful (F, Eu, Sm, La, Yb, and Lu). Key data from ground water sites include (1) water chemistry measurements (pH, conductivity, and alkalinity) and (2) elemental analyses (U, Na, Cl, Mg, Al, Mn, Br, V, and F). Supplementary data include site descriptors, information about the collection of the samples (well age, well depth, frequency of use of well, etc.), and analytical data for dysprosium.

34551 (DPST—78-146-2) **Savannah River Laboratory hydrogeochemical and stream sediment reconnaissance. Preliminary raw data release: Greenville 1° x 2° NTMS area Georgia, North Carolina, and South Carolina. National Uranium Resource Evaluation Program.** Ferguson, R.B. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Mar 1978. Contract EY-76-C-09-0001. 180p. (GJBX—47(78)). Dep. NTIS, MF A01.

Portions of document are illegible.

Preliminary results of stream sediment and ground water reconnaissance in the Greenville National Topographic Map Series (NTMS) 1° x 2° quadrangle are presented. Stream sediment samples were collected from small streams at 1413 sites for a nominal density of one site per 13 square kilometers in rural areas. Ground water samples were collected at 731 sites for a nominal density of one site per 25 square kilometers. Neutron activation analysis (NAA) results are given for uranium and 16 other elements in sediments, and for uranium and 9 other elements in ground water. Field measurements and observations are reported for each site. Analytical data and field measurements are presented in tables and maps. Statistical summaries of data and a brief description of results are given. A generalized geologic map and a summary of the geology of the area are included. Key data are presented in page-sized hard copy. Supplementary data are on microfiche. Key data from stream sites include (1) water quality measurements (pH, conductivity, and alkalinity), (2) elements that may be related to potential uranium and thorium mineralization in this area (U, Th, Hf, Ce, and Dy) and (3) elements useful for geologic classification of the sample area (Ti, V, Fe, Mn, Al, and Sc). Supplementary data from stream sites include sample site descriptors (stream characteristics, vegetation, stream width, etc.) and additional elemental analyses that may be useful (F, Eu, Sm, La, Yb, and Lu). Key data from ground water sites include (1) water chemistry measurements (pH, conductivity, and alkalinity) and (2) elemental analyses (U, Na, Cl, Mg, Al, Mn, Br, V, and F). Supplementary data include site descriptors, information about the collection of the samples (well age, well depth, frequency of use of well, etc.), and analytical data for dysprosium.

34552 (GJBX—2(78)(Vol.2)) **Aerial gamma ray and magnetic survey, Van Horn and Pecos Quadrangles, Texas. Volume II. Final report.** (GeoMetrics, Inc., Sunnyvale, Calif. (USA)). Oct 1977. Contract EY-76-C-13-1664. 170p. NTIS, MF A01.

Data obtained from the aerial gamma ray and magnetic survey of the Van Horn and Pecos Quadrangles, Texas, are presented in the form of strip charts. (LK)

34553 (GJBX—16(78)(Vol.2)) **NURE aerial gamma ray and magnetic reconnaissance survey, Thorpe area, Newark NK18-11 Quadrangle.** (LKB Resources, Inc., Huntingdon Valley, Pa. (USA)). Nov 1977. Contract EY-76-C-13-1664. 133p. NTIS, MF A01.

Portions of document are illegible.

Vol II contains the data generated by the aerial gamma-ray and magnetic survey of the Newark NK 18-11 quadrangle of the Thorpe Area. (LK)

34554 (GJBX—23(78)) **Preliminary study of favorability for uranium resources in Juab County, Utah.** Leedom, S.H.; Mitchell, T.P. (Bendix Field Engineering Corp., Grand Junction, Colo. (USA)). Feb 1978. Contract EY-76-C-13-1664. 27p. Dep. NTIS, PC A02/MF A01.

The best potential for large, low-grade uranium deposits in Juab County is in the hydrothermally altered vitric tuffs of Pliocene age. The lateral extent of the altered tuffs may be determined by subsurface studies around the perimeter of the volcanic centers in the Thomas Range and the Honeycomb Hills. Because the ring-fracture zone associated with collapse of the Thomas caldera was a major control for hydrothermal uranium deposits, delineation of the northern and eastern positions of the ring-fracture zone is critical in defining favorable areas for uranium deposits. A small, medium-grade ore deposit in tuffaceous sand of Pliocene age at the Yellow Chief mine in Dugway Dell is unique in origin, and the probability of discovering another deposit of this type is low. A deposit of this type may be present under alluvial cover in the northwestern Drum Mountains along the southern extension of the ring-fracture zone of the Thomas caldera. Festoonlike iron oxide structures and uranium deposition within permeable sandstone horizons indicate that the Yellow Chief deposit was formed by recent ground-water circulation. Granitic intrusive rocks in the Deep Creek Range and in Desert Mountain contain isolated epigenetic vein-type deposits. These rocks could be a source of arkosic sediments buried in adjacent valleys. The Pleistocene lacustrine sediments and playa lake brines may contain concentrations of uranium leached from uranium-rich rocks.

34555 (GJBX—32(78)) **NURE aerial gamma ray and magnetic reconnaissance survey, Thorpe area, Scranton NK18-8 Quadrangle. Volume I. Narrative report.** (LKB Resources, Inc., Huntingdon Valley, Pa. (USA)). Feb 1978. Contract EY-76-C-13-1664. 116p. NTIS, PC E05/MF A01.

A rotary wing combined airborne high sensitivity gamma-ray and magnetic survey of four 1:250,000 quadrangles covering portions of Pennsylvania, New Jersey, and New York was made. The results are given for the Scranton NK18-8 quadrangle. (LK)

34556 (GJBX—32(78)(Vol.2)) **NURE aerial gamma ray and magnetic reconnaissance survey, Thorpe area, Scranton NK18-8 Quadrangle.** (LKB Resources, Inc., Huntingdon Valley, Pa. (USA)). Feb 1978. Contract EY-76-C-13-1664. 121p. NTIS, MF A01.

Portions of document are illegible.

Vol II contains the data generated by the aerial gamma ray and magnetic reconnaissance survey of the Scranton NK 18-8 quadrangle of the Thorpe Area. (LK)

34557 (GJO—108(77), pp 69-93) **Status and progress of the NURE program.** Everhart, D.L. 1977.

From Uranium industry seminar; Grand Junction, CO, USA (26 Oct 1977).

In Uranium industry seminar.

Background information on the National Uranium Resource Evaluation (NURE) program is given along with operational methodology. Information is included on aerial prospecting hydrochemical reconnaissance, geologic studies, geochemical studies, remote sensing, technology development, exploration techniques, and data management. (JRD)

34558 (GJO—108(77), pp 95-102) **NURE data collection and evaluation strategies.** Horton, R.C. (Bendix Field Engineering Corp., Grand Junction, CO). 1977.

From Uranium industry seminar; Grand Junction, CO, USA (26 Oct 1977).

In Uranium industry seminar.

Collection and evaluation strategies used in the National Uranium Resource Evaluation program are described. Hydrogeochemical, airborne radiometric and magnetic, and field geology data are collected in every quadrangle. Topical studies, modeling, and classification and recognition criteria are required for assessment--the final estimate of tons of uranium. The evaluation of quadrangles has been divided into three phases: Phase I, prefield work; Phase II, field work; Phase III, report and map preparation. All evaluators--the U.S. Geological Survey, state surveys, private subcontractors and Bendix--will follow identical procedures. This is not to say that all quadrangles are identical, or that identical techniques will be applied to, or identical data recovered from, each quadrangle.

34559 (GJO—108(77), pp 103-111) **United States Geological Survey uranium and thorium resource assessment and exploration research program, fiscal year 1978.** Offield, T.W. (Geological Survey, Denver). 1977.

From Uranium industry seminar; Grand Junction, CO, USA (26 Oct 1977).

In Uranium industry seminar.

The USGS program designed to improve understanding of the nature and distribution of uranium and thorium resources of the United States is described. Studies of known uranium areas are conducted in which modern concepts of stratigraphy, sedimentation, and igneous and metamorphic petrology, together with modern geochemical and geophysical methods, are applied to obtain new insights into uranium habitat. A major goal throughout the program is to build models of uranium or thorium occurrences which can be used together with area geologic information to improve favorability estimates and resource appraisal for any given potential uranium or thorium habitat. Discussions are included on uranium geochemistry, uranium, environments, and geophysical techniques in uranium and thorium exploration. (JRD)

34560 (GJO—108(77), pp 159-170) **Exploration activities.** Chenoweth, W.L. 1977.

From Uranium industry seminar; Grand Junction, CO, USA (26 Oct 1977).

In Uranium industry seminar.

Uranium exploration activities in the United States during 1977 are highlighted by (1) the expectation of the greatest amount of drilling ever done for uranium in a single year, and (2) continued expansion of exploration into frontier areas. The continued strong demand for uranium plus today's high prices have combined to produce a situation favorable for exploration. The uranium industry is staffing up to evaluate frontier areas. All potential geologic environments in rocks of nearly all geologic ages are being evaluated. As exploration moves into deeper ground and unfamiliar areas, more reliance is being plced on geophysical and geochemical techniques; this is especially true in non-sandstone environments. The search in 1977 has been more widespread and more intense than in past years. Implementation of exploration activities is still a problem due to increased environmental restrictions which complicate land access. The uncertainties of being able to operate on the public lands in many areas have resulted in the cancellation of many exploration plans. Continuing withdrawal of public lands from mineral entry also is having a negative effect on exploration.

34561 (TM—196) **Report of examination: Little Wolf Mining and Minerals, Inc., Anklam property, Big Falls, Waupaca County, Wisconsin.** King, J.W. (Department of Energy, Grand Junction, Colo. (USA). Grand Junction Office). Mar 1978. Contract EY-76-C-13-1664. 15p. Dep. NTIS, MF A01.

Portions of document are illegible.

The property exhibits local anomalous gamma radiation associated with segregations in the granite. Most of the anomalous gamma radiation results from probable secondary uranium minerals on fracture surfaces; most of the remaining anomalous gamma radiation comes from uraninite and metamict accessory minerals; most of the fluorescence comes from weakly uraniferous opal. The uranium was probably a late stage differentiate. Neither gamma-ray logs nor scanner samples, nor cut samples (excepting one radiometric assay which, on chemical analysis, assayed 0.06% U_3O_8) reveal the presence of mineralized material containing more than 0.08% U_3O_8.

34562 **Geologic setting and relevant exploration features of the Jabiluka uranium deposits.** Hegge, M.R. (Pancontinental Min Ltd Sydney, Aust). *CIM Bull.;* **70**: No. 788, 50-61(Dec 1977).

The Jabiluka deposits in the Northern Territory of Australia comprise one of the world's greatest concentrations of uranium metal. Indicated and inferred reserves total 207,000 tons of contained U_3O_8 and 8.09 million grams (260,100 oz) of gold. This paper describes the general geology of the deposits as known to date, with emphasis on the mode of mineralization. Certain conclusions and comparisons are presented on ore genesis to aid in the search for deposits in similar environments. 10 refs.

34563 **Central ore dressing plant possible as Karoo uranium prospecting builds up.** *S. Afr. Min. Eng. J.;* **88**: No. 4133, 45, 47, 49(Oct 1977).

A large number of small deposits of uranium have been established. The Geological Survey is concentrating its disciplines in this area of high uranium potential. Geological mapping, airborne geophysical prospecting, regional stream sediment geochemistry and hydrogeochemistry, and micro- and macro-palaeontology, in addition to economic geology studies, are being used to probe some 660,000 km.

34564 **Some aspects of natural gamma radiation in ore search.** Sherrington, G.H. (Geopeko Ltd, Chatswood, Aust). *J. Geochem. Explor.;* **8**: No. 1-2, 325-335(Oct 1977).

Natural gamma radiation from the decay chains headed by ^{238}U, ^{235}U, ^{232}Th, and ^{40}K can be detected and measured by a variety of instruments. Hand-held total count scintillometers indicate a portion of the gross gamma radioactivity. Portable four-channel differential spectrometers allow some discrimination between contributions from the U, Th and K series. Similar discrimination is possible with downhole and airborne gamma-ray spectrometers. Laboratory spectrometers using high-resolution germanium detectors show the contribution of many individual isotopes. The most obvious and widespread use for all of these instruments is in exploration for U deposits. Deposits which are radiometrically simple, such as Ranger 1, Northern Territory, need less complex instrumentation than deposits such as Mary Kathleen, Queensland, which has significant ^{232}Th series activity. Radiometric complexity is also caused by disequilibrium in the U decay series. Exploration for base metal deposits can also be assisted by gamma spectrometry. The weak radiometric expression can show character attributable to recognizable events (such as K metasomatism) or can give an empirical pattern correlatable with lithology.

34565 **Uranium and coexisting element behavior in surface waters and associated sediments with varied sampling techniques used for uranium exploration.** Wenrich-Verbeek, K.J. (US Geol Surv, Denver Fed Cent, Colo). *J. Geochem. Explor.;* **8**: No. 1-2, 337-355(Oct 1977).

Optimum sampling methods in surface water and associated sediments for use in uranium exploration are being studied at thirty sites in Colorado, New Mexico, Arizona, and Utah. For water samples, filtering is recommended to increase sample homogeneity and reproducibility, because for most elements studied water samples which were allowed to remain unfiltered until time of analysis contained higher concentrations than field-filtered samples of the same waters. Acidification of unfiltered samples resulted in still higher concentrations. This is predominantly because of leaching of the elements from the suspended fraction. U in water correlates directly with Ca, Mg, Na, K, Ba, B, Li and As. In stream sediments, U and other trace elements are concentrated in the finer size fractions. Accordingly, in prospecting, grain size fractions less than 90 μm (170 mesh) should be analyzed for U. A greater number of elements (21) show a significant positive correlation with U in stream sediments than in water. Results have revealed that anomalous concentrations of U found in water may not be detected in associated sediments and vice versa. Hence, sampling of both surface water and coexisting sediment is strongly recommended.

34566 **Stream sediment orientation program for uranium in the Alligator River Province, Northern Territory, Australia.** Foy, M.F.; Gingrich, J.E. *J. Geochem. Explor.;* **8**: No. 1-2, 357-364(Oct 1977).

Sediment samples were collected from streams draining the Koongarra uranium deposit and the small uranium mines in the South Alligator Valley. Determinations for U, Cu and Pb on various size fractions, taken from each of these samples, indicated that the best results were obtained for U from the minus 200-mesh fraction, but the train from the Koongarra ore deposit was very short. Cu and Pb were not found to be very useful as indicator elements for U. Alpha-track films were used to determine the Rn content of each sample and the ratio of alpha-track film reading to U content was found to define anomalous drainage areas around the mineralization in the Koongarra area. The areas so defined were of sufficient magnitude to be defined in a reconnaissance stream sediment program.

34567 **Uranium isotopes in groundwater: their use in prospecting for sandstone-type uranium deposits.** Cowart, J.B.; Osmond, J.K. (Fla

State Univ, Tallahassee). *J. Geochem. Explor.;* **8**: No. 1-2, 365-379(Oct 1977).

The relative abundances of dissolved ^{238}U and its daughter ^{234}U appear to be greatly affected as the uranium is transported downdip in sandstone aquifers. In an actively forming uranium accumulation at a reducing barrier, an input of ^{234}U occurs in proximity to the isotopically non-selective precipitation of uranium from the water. The result is a downdip water much lower in uranium concentration but relatively enriched in ^{234}U. The measurement of isotopic, as well as concentration, changes may increase the effectiveness of hydrogeochemical exploration for uranium. The investigation includes the uranium isotopic patterns in aquifers associated with known uranium ore bodies in the Powder River and Shirley Basins, Wyoming, and Karnes County, Texas, U.S.A., In addition, the Carrizo sandstone aquifer of Texas was studied in detail, and the presence of a uranium accumulation was inferred.

34568 Application of nuclear geophysical methods in geologic practice. Kobr, M.; Dedacek, K. (Karlova Universita, Prague (Czechoslovakia). Prirodovedecka Fakulta). *Geol. Pruzkum;* **19**: No. 1, 15-18(Jan 1977). (In Czech).

Methods of nuclear geophysics are described which are applied at the Department of Nuclear Geophysics Methods of the Leningrad State University. They include the following laboratory methods: a) determination of the uranium content of ore samples by gamma spectrometry with Ge(Li) and GeIn detectors which allow the determination of the radioactivity equilibrium in the uranium series; b) multi-component neutron activation analysis of samples from a Au-Ag deposit; and the following in situ methods: a) gamma-gamma logging in ore and coal bores; b) the X-ray fluorescence method. The techniques of suppressing matrix effects are given for the fluorescence method. Various field variants of these methods are used, e.g., for logging, for mine wall measurements and for ore treatment, especially in Sn deposits.

34569 Evaluation of the uranium potential of areas covered by lake waters, using geophysical, geochemical and radiometric techniques. Beck, L.S.; Hoeve, J. (Saskatchewan Dept. of Mineral Resources, Regina (Canada)); Parslow, G.R. (Regina Univ., Saskatchewan (Canada)). pp 261-276 of Recognition and evaluation of uraniferous areas. Proceedings of a technical committee meeting held in Vienna, 17-21 November 1975. Vienna; IAEA (1977).

From Technical committee meeting on recognition and evaluation of Uraniferous areas; Vienna, Austria (17 Nov 1975).

See CONF-7511132—.

To evaluate various techniques of exploring for uranium in areas underlain by lakes, the Alces Lake area was chosen for study. The lake is situated about 30km northeast of Eldorado in northern Saskatchewan (59 degrees 40 minutes N:108 degrees 0.3 minutes W). The Ace-Fay and Verna pitchblende deposits of Eldorado Nuclear Limited are associated with the St. Louis fault, which is believed to extend under Alces Lake. The lake was systematically sampled at 20-m intervals along grid-lines spaced 200m apart. At each sample location, a lake-bottom sediment sample was taken, 2 litres of lake water from the basal metre of the lake were collected and depth soundings and VLF measurements were made. The lake-water samples were analysed in the field for radon and subsequently in the laboratory for uranium. Lake sediment samples were analysed for uranium. Several of the lines were traversed with an underwater scintillometer which was operated by towing the probe along the lake bottom from a boat and also by guiding the probe along the lake bottom by scuba divers. The paper describes and evaluates the various techniques and discusses the results. In view of the fact that as much as 30% uranium districts within the Canadian Shield are covered by lake water, these techniques will be of considerable interest for the further evaluation of these uraniferous areas.

34570 Basic data for uranium prospecting in Argentina. Belluco, A.; Rodriguez, E.; Martinez, C.; Marinkeff, K. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). pp 183-197 of Recognition and evaluation of uraniferous areas. Proceedings of a technical committee meeting held in Vienna, 17-21 November 1975. Vienna; IAEA (1977). (In Spanish)

From Technical committee meeting on recognition and evaluation of Uraniferous areas; Vienna, Austria (17 Nov 1975).

See CONF-7511132—.

After dealing briefly with the geochemical cycle of uranium in the earth's crust, and indicating the principal conditions under which different types of deposits are formed, the paper goes on to determine the uraniferous ore of mainland Argentina (approximately 900000 km^2). Since evidence for the presence of uranium and other radioactive elements in many parts of the country has long been available, an attempt was made to systemize the existing information and classify the uraniferous sites so as to determine their temporal, spatial and genetic relationships with the different containing rocks. In addition, a study was made of the factors which contribute to the concentration of uranium in rocks which are accessible to prospecting (litho-stratigraphy, geological history, mettallogenic cycles, etc.). On the basis of these studies and considering the regional geology of Argentina, 21 "regional environments" were defined with varying degrees of probability of containing uranium; these environments will be submitted to long-term regional prospecting studies. It was necessary, however, to make a further sub-division into more homogeneous units with more clearly graded levels of priority, with the result that there are 65 "prospecting units". Each of these units, in order of priority, will be subjected to systematic prospecting. Exploratory work on a suitable scale will be carried out in the "uraniferous" districts of the "prospecting units". The main features of Argentine geology relating to the likelihood of uranium occurrences are briefly described, and maps of the large geotechtonic areas and the "regional environments" are included.

MINING

REFER ALSO TO CITATION(S) 34667, 35905

34571 (GJO—108(77), pp 171-180) **Uranium production trends.** Facer, J.F. Jr. 1977.

From Uranium industry seminar; Grand Junction, CO, USA (26 Oct 1977).

In Uranium industry seminar.

The year 1977 has been one of cautious optimism for the future of the uranium production industry. Ore production will be about 10,000,000 tons, and production of uranium concentrate will exceed 14,000 tons of U_3O_8 for the first time since 1963. Two new mills are processing uranium ore, and there is considerable activity in the recovery of uranium by in situ leaching and as a by-product of phosphoric acid and copper production.

34572 (GJO—108(77), pp 237-268) **Foreign uranium developments.** Wright, R.J. (Department of Energy, Washington, DC). 1977.

From Uranium industry seminar; Grand Junction, CO, USA (26 Oct 1977).

In Uranium industry seminar.

The mining scene and the political scene in the important uranium-producing nations of the world (other than the United States) is described. Interwoven with these subjects are discussions of certain geologic matters, with emphasis on the geology and ore guides of unconformity-related deposits of Canada and Australia. Discussions of mining in Africa and Europe are also included. (JRD)

34573 Some characteristics of the air in a uranium mine. Renoux, A. (Univ. de Bretagne Occidentale, Brest, France); Barzic, J.Y.; Madelaine, G.J.; Zettwoog, P. *Nucl. Technol.;* **37**: No. 3, 313-327(Mar 1978).

The radon content in the atmosphere of a uranium mine, 183 pCi l^{-1}, was found during the varied phases of the excavation (drilling, blasting, and clearing) to vary between 63 and 3600 pCi l^{-1}. Radioactive equilibrium was not found to be reached for radon and its daughter products. By means of a seven-stage Andersen cascade impactor, the particle size distribution for the aerosols of the mine was determined as well as the alpha-particle activities on each disk of the impactor and on the millipore filter placed behind each stage. This yielded the information that the major portion of alpha activity in the test mine is connected with aerosols having a radius <0.4 μm. During excavation, more than 80% of the radioactivity is located on aerosols with radius smaller than 0.15 μm; this radioactive aerosol is the smallest found after blasting. In all cases, the alpha radioactivity associated with large particles ($R > 1$ μm) is very small ($<3\%$). This indicates that if the Andersen impactor is used carelessly, it may yield an erroneous distribution of the radioactivity in a uranium mine. 11 tables. 13 figures.

34574 Australian uranium and the election. Saddler, H.; Martin, B. (Australian National Univ., Canberra). *New Sci.;* **76**: No. 1081, 644-645(8 Dec 1977).

The international and national complexities of the situation in Australia over the question of mining of the country's large and rich uranium deposits are explored with especial reference to the pending general election. The present position is ironical since access to low cost uranium would give a welcome boost to the nuclear industry which is enthusiastically supported by the Australian prime minister and his colleagues yet the Australian government is unable to promote mining as rapidly as it would like because of the international commitments it has made to provide a justification for its policy.

34575 In-situ leach mining for uranium. Davis, G.R. (Atlantic Richfield Co., Corpus Christi, Tex., USA); Miller, R.E. (U.S. Steel Corp., Corpus Christi, Tex., USA); Swift, G.G. (Dalco Oil Co., Dallas, Tex. (USA)). pp 193-200 of Uranium ore processing. Proceedings of an advisory group meeting organized by the IAEA and held in Washington, D.C., 24-26 November 1975. Vienna; IAEA (1976).

From Technical committee meeting on recognition and evaluation of Uraniferous areas; Vienna, Austria (17 Nov 1975).

See CONF-7511132—.

The first commercial mine for production of uranium by dissolving the element in chemical solutions injected into and produced from wells has been opened in Texas. This paper describes the geology of the region, the operation of the processing plant and the development of the mine. Injection wells, production wells and disposal wells are described. Hydrology studies conducted prior to start-up are outlined and environmental considerations and the development of baseline data are discussed in detail.

FEED PROCESSING

REFER ALSO TO CITATION(S) 34571, 34671

34576 (GJO—108(77), pp 181-194) **Uranium processing developments.** Jones, J.Q. 1977.

From Uranium industry seminar; Grand Junction, CO, USA (26 Oct 1977).

In Uranium industry seminar.

The basic methods for processing ore to recover the contained uranium have not changed significantly since the 1954-62 period. Improvements in mill operations have been the result of better or less expensive reagents, changes in equipment, and in the successful resolvement of many environmental matters. There is also an apparent trend toward large mills that can profitably process lower grade ores. The major thrust in the near future will not be on process technology but on the remaining environmental constraints associated with milling. At this time the main "spot light" is on tailings dam and impoundment area construction and reclamation. Plans must provide for an adequate safety factor for stability, no surface or groundwater contamination, and minimal discharge of radionuclides to unrestricted areas, as may be required by law. Solution mining methods must also provide for plans to restore the groundwater back to its original condition as defined by local groundwater regulations. Basic flowsheets (each to finished product) plus modified versions of the basic types are shown. (JRD)

34577 (GJO—108(77), pp 195-226) **Production capability and supply.** Klemenic, J. 1977.

From Uranium industry seminar; Grand Junction, CO, USA (26 Oct 1977).

In Uranium industry seminar.

The strong market for uranium of recent years is about to usher in a new era in domestic uranium production. The spot market price of uranium has remained relatively stable at a little over $40/lb for more than 18 months. Many of the recent contracts for delivery in the early 1980s are calling for prices in the range of $40 to $65 per lb in year-of-delivery dollars. Low-grade, high-cost projects, such as uranium recovery from mill tailings and the reopening of "mined-out" ore bodies, have already been initiated. New underground mines to produce at greater depths, and new surface mines to recover lower grade ores, are being developed or seriously planned. In keeping with this movement to recover uranium from low-grade ore and other high cost materials, the Grand Junction Office has examined, for the first time, the production capability of the domestic industry assuming a $30/lb (or less) "forward cost" resource base. As in the past, keep in mind that the market price needed to stimulate full production of a given resource base may be significantly higher than the estimated forward cost of producing that resource. Results of the $30/lb study are presented. (JRD)

34578 (NRCN—435) **Influence of various manufacturing parameters on some characteristics of UO_2 powders and their sintering behaviour. Nuclear fuel research and developemnt.** Mintz, M.H.; Vaknin, Sh.; Kremener, A.; Hadari, Z. (Israel Atomic Energy Commission, Beersheba. Nuclear Research Center-Negev). Feb 1977. 88p. Dep. NTIS (US Sales Only), PC A05/MF A01.

Various parameters in the process of manufacturing uranium dioxide are examined and their influence on the characteristics and sintering behavior of the powders obtained is established. In addition some correlations between the powder aggregates microstructure and their adhesion properties and sintering behaviour are indicated. Shrinkage during the sintering process is also discussed.

34579 Flow photometric monitor for uranium in carbonate solutions. Jablonski, B.B.; Leyden, D.E. (Univ. of Denver). *Anal. Chem.;* **50**: No. 3, 404-407(Mar 1978).

The reaction between U(VI) and 2,3-dihydroxynaphthalene-6-sulfonic acid is the basis of a continuous flow photometric monitor for uranium in carbonate solution. Linearity in the 0 to 100 ppM range has been observed with relative standard deviation of 1.1% at 60 ppM uranium and a lower detection limit of 3.5 ppM. The applicability of the method has been tested by analyzing process samples from a solution mining operation. Very few interferences have been observed. 1 figure, 4 tables.

34580 Improved process for recovery of uranium from wet process phosphoric acid. Wiewiorowski, T.K. ; Thornsberry, W.L. South African Patent 77/0983/A/. 18 Feb 1977. Priority date 8 Mar 1976, United States of America (USA). 21p.

A process is described for removing iron from an extractant containing uranium values comprising a dialkylphosphoric acid and a trialkylphosphine oxide dissolved in a water-immiscible organic solvent and having dissolved therein trivalent iron. The process comprises contacting the extractant with substantially iron-free dilute aqueous phosphoric acid at least once to transfer the trivalent iron to the iron-free dilute aqueous phosphoric acid and disengaging the dilute aqueous phosphoric acid containing the transferred trivalent iron from the extractant.

34581 (ORNL-tr—4581) **Recovery of uranium from phosphoric acid.** Cordero, G.; Jodra, L.G.; Otero, J.L.; Josa, J.M. Translated by T.W. Appich Jr. from *Energ. Nucl. (Madrid);* **21**: No. 109, 297-303(1977). 13p. (CONF-770505—13(Trans)). Dep. NTIS, PC A02/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

The Spanish phosphoric acid industry is discussed. A synergistic mixture of D ZEHPA and TOPO was used to recover uranium from phosphoric acid. A pilot plant was constructed capable of treating 7 m^3/day. Recovery was 85-90 percent, and the ammonium uranyl tricarbonate was calcinated at 550°C to yield a product with 96-98 percent U_3O_8. Prospects for industrial recovery of uranium are promising. (DLC)

34582 Treatment of an isolated high-grade, low-tonnage uranium orebody. Ajuria-Garza, S. (Instituto Nacional de Energia Nuclear, Mexico City); Jamrack, W.D. (International Atomic Energy Agency, Vienna (Austria)). pp 107-117 of Uranium ore processing. Proceedings of an advisory group meeting organized by the IAEA and held in Washington, D.C., 24-26 November 1975. Vienna; IAEA (1976).

From Meeting of the advisory group on uranium ore processing; Washington, DC, USA (24 Nov 1975).

See CONF-751192—.

A completely integrated process leading to a commercial-grade uranium concentrate has been developed for the El Nopal orebody which contains 115000t of ore with an average grade of 0.283%, equivalent to 325t of U_3O_8. The process consists of crushing (from -12 in. to -1.5 in.), heap leaching with recirculation, a special type of countercurrent washing (also in the heap), solvent extraction to give an exceptionally high uranium concentration, re-extraction, precipitation with ammonium hydroxide, filtration and calcining. The main factors that influence heap leaching are analysed in detail: heap geometry, crushed ore size distribution, base design and construction, method of heaping, acid feeding method, flow of liquors through the heap and washing procedures. Leaching efficiencies range from 80 to 85% and washing efficiencies from 96 to almost 100% with an overall extraction efficiency of 77 to 85%. Acid consumption is usually less than 25kg/t of ore. The leaching and washing processes described are designed to use an overall solid-to-liquid ratio of about 3:1 thus producing very concentrated liquors with a U_3O_8 content of about 7g/l. These liquors are filtered and fed directly to a solvent extraction system using Alamine 336 (tri-capryl amine) and isodecanol in kerosene. The high feed concentration makes it possible to use a high concentration of amine. The organic solvent contains 120g/l of Alamine and 98g/l of isodecanol. Re-extraction can be with a saline solution containing 100g/lNH_4Cl and 250g/l$(NH_4)SO_4$. The strong liquor obtained from re-extraction contains 70-75g/lU_3O_8. The remaining steps of precipitation, filtration and calcining can then follow general practice and lead to a product which meets currently accepted commercial specifications. As an alternative, nitrate re-extraction has been shown to produce a solution of about 70g/l which will feed directly to tributyl phosphate (TBP) refining without the necessity of ever producing a concentrate.

34583 Uranium recovery from bituminous shales at Ranstad. Andersson, A. (Luossavaara-Kiirunavaara AB (LKAB), Stockholm, Sweden). pp 171-176 of Uranium ore processing. Proceedings of an advisory group meeting organized by the IAEA and held in Washington, D.C., 24-26 November 1975. Vienna; IAEA (1976).

From Meeting of the advisory group on uranium ore processing; Washington, DC, USA (24 Nov 1975).

See CONF-751192—.

LKAB is planning a new plant for the recovery of uranium from low-grade bituminous shales at Ranstad in south-western Sweden. The processes have been developed at the existing plant which has served as a testing facility since 1968. After mining in open-pit and underground mines the ore is treated by heavy-media separation to separate the shale from limestone inclusions. The shale is crushed to -2 mm and acid-cured with sulfuric acid before percolation leaching. Seven large vats will be used for a leaching time of 6 days, including 1 day of washing. Acid consumption is about 60 kg/t of shale, giving a uranium recovery of 80%. The uranium is recov-

ered from the leach solution by solvent extraction followed by precipitation and drying. Mining of a low-grade shale deposit will be a disturbing element to the environment. Open-pit and underground mining and tailings disposal will affect the scenery as well as the groundwater table. There is always a danger that water seepage will pollute both surface and groundwaters. The radiotoxicity of the tailings is carefully studied but, as yet, no great difficulties are foreseen.

34584 Notes on technical aspects of problems connected with the treatment of several new-generation Australian uranium occurrences. Goldney, L.H.; Hartley, F.R.; McMahon, R.G.P. (Australian Mineral Development Labs., Frewville). pp 93-105 of Uranium ore processing. Proceedings of an advisory group meeting organized by the IAEA and held in Washington, D.C., 24-26 November 1975. Vienna; IAEA (1976).

From Meeting of the advisory group on uranium ore processing; Washington, DC, USA (24 Nov 1975).

See CONF-751192—.

The paper has three distinct parts. The first describes characteristics of the Nabarlek orebody as they affect any proposed mining and treatment process. The mineralogy of the Nabarlek orebody is well suited to the application of traditional acid leach solvent extraction technology, and parameters have now been defined for a satisfactory flowsheet. However, the unique feature of this orebody is its high grade, and this has presented several problems of significance, which form the main subject of this note. The second part of the paper describes the technical feasibility of recovering uranium from a carnotite-bearing ore by pelletizing and percolation leaching with sodium carbonate/sodium bicarbonate solutions. The investigation was prompted by a particular problem presented by this orebody in the very poor settling characteristics displayed during pilot plant operations using more conventional agitation leaching/countercurrent washing. Using lime as a cementing agent, pellets were prepared and laboratory and pilot-scale percolation leaching indicated that uranium extraction in excess of 97% could be achieved without mechanical breakdown of the pellets. The paper is rounded off by a note on the problems of extracting uranium from a third type of uranium mineralization which occurs over a relatively wide area in central Queensland, where uranium appears in brannerite and zircon in a matrix which includes apatite and carbonate minerals. This note refers to work carried out specifically on a 'new generation' find - the Valhalla Deposit adjacent to Mt Isa.

34585 Studies on the recovery of uranium from low-grade ores in India. Jayaram, K.M.V.; Dwivedy, K.K.; Deshpande, A.S.; Ramachar, T.M. (Department of Atomic Energy, Hyderabad (India). Atomic Minerals Div.). pp 155-169 of Uranium ore processing. Proceedings of an advisory group meeting organized by the IAEA and held in Washington, D.C., 24-26 November 1975. Vienna; IAEA (1976).

From Meeting of the advisory group on uranium ore processing; Washington, DC, USA (24 Nov 1975).

See CONF-751192—.

Investigations were carried out to utilize the available paramarginal and low-grade ores - chlorite schists, amphibolites, carbonate ores, clays and quartzites - analyzing between 0.027 and 0.08% U_3O_8. In addition, tests were undertaken on the technical and economic feasibility of recovering uranium as a byproduct from the copper flotation tailings and phosphorites. Heap and bacterial leaching tests were conducted on quartz-chlorite schists from the Singhbhum district, Bihar, analyzing about 0.03% U_3O_8. Studies also showed that the ores harbour active Ferrobacillus ferrooxidans. Studies on 10-mesh samples of amphibolites from Inderwa, Bihar, (0.08% U_3O_8) showed that only 32.8% recovery could be obtained by wet tabling and 85% by agitation leaching, while static leaching tests yielded 81% recovery in 24 hours of contact time. Similar tests on calcareous phyllites (0.05% U_3O_8) with 30 kg/t Na_2CO_3 and 8 kg/t $NaHCO_3$ yielded 86% uranium leachability at ambient temperature. Biogenic uraniferous clay from Udaisagar (0.029% U_3O_8) yielded 43.3% uranium recovery using 1000 l/t of neutral water for 6 h. Percolation leaching tests were conducted with hard quartzites (0.06% U_3O_8), and the results showed that 81% uranium could be recovered in 24 days. Although preliminary ore dressing studies on tailings obtained from the copper flotation (0.013% U_3O_8) at Surda yielded a concentrate analyzing 0.063% U_3O_8 at 66% recovery, recent tests on the tailings from the copper concentrator indicated only 48% recovery at a grade of 0.112% owing to decrease in the feed grade. Studies on the utilization of large-capacity gravity machines and selective mining of uranium-rich copper lodes may render this source economic.

34586 Uranium ore processing in Spain. Josa, J.M. (Junta de Energia Nuclear, Madrid (Spain)). pp 41-52 of Uranium ore processing. Proceedings of an advisory group meeting organized by the IAEA and held in Washington, D.C., 24-26 November 1975. Vienna; IAEA (1976). (In Spanish)

From Meeting of the advisory group on uranium ore processing; Washington, DC, USA (24 Nov 1975).

See CONF-751192—.

The paper presents a review of the Spanish needs of uranium concentrates and uranium ore processing technology and trends in Spain. Spain produces approximately 200t U_3O_8/a at two facilities. One plant in the south (Andujar, Jaen) can obtain 70t U_3O_8/a and uses a conventional acid leaching process with countercurrent solvent extraction. A second plant, situated in the west (Ciudad Rodrigo, Salamanca) has started in 1975 and has a capacity of 120-130t U_3O_8/a, using acid heap leaching and solvent extraction. There is another experimental facility (Don Benito, Badajoz) scheduled to start in 1976 and expected to produce about 25-35t U_3O_8/a as a by-product of the research work. For the near future (1978) it is hoped to increase the production with: (a) A new conventional acid leaching/solvent extraction plant in Ciudad Rodrigo; its tentative capacity is fixed at 550t U_3O_8/a. (b) A facility in the south, to recover about 130t U_3O_8/a from phosphoric acid. (c) Several small mobile plants (30t U_3O_8/a per plant); these will be placed near small and isolated mines. The next production increase (1979-1980) will come with the treatment of sandstones (Guadalajara and Cataluna) and lignites(Cataluna); this is being studied. There are also research programmes to study the recovery of uranium from low-grade ores (heap, in-situ and bacterial leaching) and from other industries.

34587 Recent trends in Canadian uranium processing. Lendrum, F.C. (F.C. Lendrum Consulting Ltd., King City, Ontario, Canada); McCreedy, H.H. (Department of Energy, Mines and Resources, Ottawa, Ontario (Canada)). pp 13-17 of Uranium ore processing. Proceedings of an advisory group meeting organized by the IAEA and held in Washington, D.C., 24-26 November 1975. Vienna; IAEA (1976).

From Meeting of the advisory group on uranium ore processing; Washington, DC, USA (24 Nov 1975).

See CONF-751192—.

Relatively few changes have been made during the past few years in the overall processing technique for Canadian uranium ores. However, there is a continued interest in new techniques and many are being tested, some with encouraging results. Some of these new methods are likely to be applied in the new plants that are being contemplated in response to the improved uranium market.

34588 Uranium as a by-product and by-products of uranium production. McGinley, F.E.; Facer, J.F. (Energy Research and Development Administration, Grand Junction, Colo. (USA). Grand Junction Office). pp 181-187 of Uranium ore processing. Proceedings of an advisory group meeting organized by the IAEA and held in Washington, D.C., 24-26 November 1975. Vienna; IAEA (1976).

From Meeting of the advisory group on uranium ore processing; Washington, DC, USA (24 Nov 1975).

See CONF-751192—.

There has been no large-scale production of uranium as a by-product in the United States of America. During the 1950s and early 1960s small tonnages of uranium were recovered as a by-product of the phosphate industry. With increasing demand and correspondingly higher prices for uranium there is a renewed interest in uranium recovery from phosphates. The possible recovery of uranium from porphyry copper waste dump leach liquors is also being re-examined. Because of the concern about the adequacy of uranium resources in conventional-type deposits, other low-grade sources of uranium such as the Chattanooga shale (60 ppm U) are being re-evaluated. Most uranium recovered in the USA comes from sandstone-type ores with little or no other metals of commercial interest. Some ores, however, contain sufficient vanadium to warrant recovery. Nearly all ores contain traces of other metals, many of which either have been recovered on a small scale at one time or another or the possibilities of recovery have been investigated. They include molybdenum, rhenium, selenium, copper, silver, scandium, arsenic, mercury, thorium, ionium, protactinium and radium. Uranium ore processors should be alert to the possibility of recovering these and other metals which may occur in uranium ores.

34589 Stored technology for possible use in uranium ore processing. Seidel, D.C. (Bureau of Mines, Salt Lake City, Utah (USA). Salt Lake City Metallurgy Research Center). pp 79-89 of Uranium ore processing. Proceedings of an advisory group meeting organized by the IAEA and held in Washington, D.C., 24-26 November 1975. Vienna; IAEA (1976).

From Meeting of the advisory group on uranium ore processing; Washington, DC, USA (24 Nov 1975).

See CONF-751192—.

Although no major flowsheet changes have been made in recent years, the uranium industry has produced a number of processing innovations which have not been fully utilized. It is probable that several of these techniques can offer improvements over current processing methods. Recently, development studies and applications of continuous ion exchange have increased; also, renewed interest in leaching modifications and autogenous grinding have become evident. In general, uranium processing has matured and is effectively used with ores now being fed to mills throughout the world. Much

of the current development work relates to unit operations and processes for lower-grade ore.

34590 Processing of low-grade uranium ores in the USSR. Skorovarov, D.I.; Laskorin, B.N.; Ivanov, G.F.; Skrinichenko, M.L.; Smirnov, I.P.; Nosov, V.D.; Dorofeev, V.I. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow). pp 141-152 of Uranium ore processing. Proceedings of an advisory group meeting organized by the IAEA and held in Washington, D.C., 24-26 November 1975. Vienna; IAEA (1976). (In Russian)

From Meeting of the advisory group on uranium ore processing; Washington, DC, USA (24 Nov 1975).

See CONF-751192—.

The paper is a further contribution to the study of the technology of uranium ore processing in the USSR, including that of low-grade ores. It describes a radiometric method of uranium ore enrichment, the use of autoclaves in processing technology, underground leaching and the sorption and extraction of uranium from pulps and solutions. It emphasizes the scientific and technical level achieved in the USSR, which has enabled a wide variety of problems in the processing of uranium raw materials and in environmental protection to be effectively solved.

34591 Some recent improvements in a uranium processing pilot-plant at the Ningyo-toge mine. Takenaka, S.; Kawate, H. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan); Asahi Chemical Industry Co., Ltd., Tokyo, Japan). pp 55-66 of Uranium ore processing. Proceedings of an advisory group meeting organized by the IAEA and held in Washington, D.C., 24-26 November 1975. Vienna; IAEA (1976).

From Meeting of the advisory group on uranium ore processing; Washington, DC, USA (24 Nov 1975).

See CONF-751192—.

Since 1964 the uranium processing plant at the Ningyo-toge mine has been modified and extended. In 1970 an ammonium diuranate (ADU) producing process was added to the plant, and a pilot plant with an ore-processing capacity of 50t/d was brought into operation. As a result of this operation the process which produces high-purity ADU was confirmed. An electrolytic reduction plant for the pilot operation was constructed by the Asahi Chemical Industry Co. in 1972. Experiments on the reduction of uranyl chloride solution were carried out with good results. Hydrofluorination facilities were added to the plant in 1974 and experiments on the hydrofluorination of UCl_4 started. The experiments also studied the characteristics of hydrated UF_4. Preliminary experiments on dehydration from hydrated UF_4 were carried out to determine the dehydration conditions and the properties of the UF_4 in the laboratory at the Tokai Works, PNC. The results of these dehydration experiments and UF_4 conversion tests were excellent.

ENRICHMENT

REFER ALSO TO CITATION(S) 34621, 34622, 34623, 34624, 34661, 34677, 35751

34592 (GJO—108(77), pp 3-18) **Uranium enrichment policies.** Schwennesen, J.L. (Department of Energy, Washington, DC). 1977.

From Uranium industry seminar; Grand Junction, CO, USA (26 Oct 1977).

In Uranium industry seminar.

A review of U enrichment policies is presented. Discussions are included on uranium resource assessment, uranium enrichment activities, DOE enrichment plants, tails assay, DOE natural uranium stockpile, DOE enrichment services, and nuclear fuel assurances. (JRD)

34593 (GJO—108(77), pp 19-36) **Uranium enrichment plans.** Gagne, R.W.; Thomas, D.C. (Department of Energy, Washington, DC). 1977.

From Uranium industry seminar; Grand Junction, CO, USA (26 Oct 1977).

In Uranium industry seminar.

The status of existing uranium enrichment contracts in the US is reviewed and expected natural uranium requirements for existing domestic uranium enrichment contracts are evaluated. Uncertainty in natural uranium requirements associated with requirements-type and fixed-commitment type contracts is discussed along with implementation of variable tails assay. (JRD)

34594 (SAND—78-8216) **Research on aerodynamic means of isotope enrichment.** Cattolica, R.J.; Gallagher, R.J.; Talbot, L.; Willis, D.R.; Hurlbut, F.C.; Fiszdon, W.; Anderson, J.B. (Sandia Labs., Albuquerque, N.Mex. (USA); Sandia Labs., Livermore, Calif. (USA)). Mar 1978. Contract EY-76-C-04-0789. 121p. Dep. NTIS, PC A06/MF A01.

The results of a research program directed toward the understanding of the fundamental gas dynamics involved in aerodynamic isotope enrichment are summarized. The specific aerodynamic isotope enrichment method which was examined in this research is based on a velocity slip phenomenon which occurs in the rarefied hypersonic expansion of a heavy molecular weight gas and a light carrier gas in a nozzle or free jet. This particular aerodynamic method was chosen for study because it contains the fundamental molecular physics of other more complex techniques within the context of a one-dimensional flow without boundary effects. From both an experimental and theoretical modeling perspective this provides an excellent basis for testing the experimental and numerical tools with which to investigate more complex aerodynamic isotope enrichment processes. This report consists of three separate parts. Part I contains a theoretical analysis of the velocity slip effect in free jet expansions of binary and ternary gas mixtures. The analysis, based on a source flow model and using moment equations is derived from the Boltzmann equation using the hypersonic approximation. Part II contains the experimental measurements of velocity slip. The numerical simulation of the slip process was carried out by using a Monte-Carlo numerical technique. In addition, comparisons between the theoretical analysis of Part I and the experiments are presented. Part III describes impact pressure measurements of free jet expansions from slot shaped two dimensional nozzles. At least two methods of aerodynamic isotope enrichment (opposed jet and velocity slip) would depend on the use of this type of two dimensional expansion. Flow surveys of single free jet and the interferene of crossed free jets are presented.

34595 Cascade technique for the South African enrichment process. Grant, W.L.; Wannenburg, J.J.; Haarhoff, P.C. (UCOR (Uranium Enrichment Corp of S Afr Ltd, Pretoria)). *AIChE Symp. Ser.;* **73**: No. 169, 20-24(1977).

In order to establish the principle on which the technique is based, experimental data on mixing, perpendicular to flow lines in axial flow compressors, are first presented. By introducing a tracer gas at various points on the compressor inlet, and observing the tracer distribution over the compressor outlet, it may be shown that the tracer is distributed over a relatively small area. As a result, a number of parallel streams of different isotopic composition may be introduced into the compressor and will be compressed without significant mixing between them. A diagrammatic description of the helikon technique is presented. In effect, a large number of small stages are incorporated in one module, and these stages share a common pair of compressors. An alternative description of the technique is based on the maintenance of a concentration gradient over the compressor. 3 refs.

34596 Technological aspects of the separation nozzle process. Becker, E.W.; Bier, W.; Schubert, K.; Schuette, R.; Seidel, D.; Sieber, U. (Karlsruhe Nucl Res Cent, Inst fuer Kernverfahrenstech, Ger). *AIChE Symp. Ser.;* **73**: No. 169, 25-29(1977).

A short description of the basic features of the process is given in addition to an outline of the most important step in the technological development. 8 refs.

34597 Oxidizing agent and reducing agent. Miyake, T.; Seko, M.; Tanouchi, M.; Onizuka, H.; Obanawa, H. (to Asahi Chemical Industry Co. Ltd., Osaka (Japan)). Japanese Patent 1977-34,197/A/. 11 Sep 1975. 8p. (In Japanese).

A method is provided to chemically separate a uranium isotope by means of oxidizing and reducing chromatography using an ion exchanger. An ion exchange resin is used to effect oxidizing and reducing reaction in an interface between a zone of uranium adsorption and a zone of oxidizing agent adsorption or in an interface between an uranium adsorbent and a zone of reducing agent adsorption. In enriching the uranium isotope at the interface, and where an oxidizing agent or reducing agent is arranged at upstream of the uranium ion adsorbed to the ion exchange resin, a distribution ratio of metal ion of reduced substance resulting from the oxidizing reaction or metal ion of oxidized substance resulting from the reducing reaction to the ion exchanger is less than 3.0, whereas, where the oxidizing agent or reducing agent is arranged at downstream from the zone of uranium adsorption, the distribution ratio of the oxidizing agent or reducing agent to metal ion exchange resin is in excess of 2.

34598 New separation method of isotopes. Miyake, T.; Takeda, K.; Ikeda, A.; Seko, M. (to Asahi Chemical Industry Co. Ltd., Osaka (Japan)). Japanese Patent 1977-24,700/A/. 16 Aug 1975. 8p. (In Japanese).

The object of this invention is to use cation exchanger resin particles whose particle-size distribution is uniform as an adsorbent thereby enhancing an efficiency of separation of uranium isotope. An oxidizing solution is permeated into a uranium adsorbing region of cation exchanger to oxidize tetrauranium ion into hexauranium ion while an interface is formed between the uranium adsorbing region and the oxidizing region to separate the isotope in the vicinity of the interface. Further, a urananium solution is permeated into a reducing region of cation exchanger to reduce hexauranium ion into tetrauranium ion while an interface is formed between the reducing region

and the uranium adsorbing region to separate the isotope in the vicinity of the interface. The cation exchange resin is used in which the particle diameter of more than 80% of all particles is between 3/4 times to 4/3 times of the average particle diameter of all particles and the average particle diameter is between 12.5 μ to 75 μ.

34599 Separation method with efficiency improved. Miyake, T.; Takeda, K.; Ikeda, A.; Seko, M. (to Asahi Chemical Industry Co. Ltd., Osaka (Japan)). Japanese Patent 1977-22,699/A/. 14 Aug 1975. 9p. (In Japanese).

A method is given to efficiently separate uranium isotope using cation exchange resins which are uniform and have many gaps. The uranium isotope is separated using cation exchange resins formed by mixing and copolymerizing non-polymerizing components (for example, such as chlorobenzene, benzonitrile, benzoic acid methyl, etc.), which have an affinity relative to an additive polymerizing monomer such as styrene, vinyl toluene, ethyl vinyl benzene, divinylbenzene, into said monomer in the weight ratio of 0.37 to 7.80, and the thus obtained copolymer is sulfonated.

GASEOUS DIFFUSION

34600 Boundary layer effect in the gaseous diffusion unit for isotope separation. Isomura, S. (Institute of Physical and Chemical Research, Wako, Saitama (Japan)). *Rikagaku Kenkyusho Hokoku;* **53**: No. 1, 26-32(Jan 1977). (In Japanese).

An experimental investigation was carried out on the effect of boundary layer in a gaseous diffusion unit for isotope separation. Pipe type barriers were used and the value of boundary layer effect for a single process was measured in separating argon isotopes. The result thus obtained was compared with the existing theory. Good agreement was obtained between the value calculated from the theory and that of the experiment in the region of turbulent gas flow in the pipe. It is possible to apply this experimental method in evaluating the separating characteristics also of large barriers such as those used in a plant for uranium enrichment.

CENTRIFUGATION

34601 CENTAR gas centrifuge enrichment project: economics and engineering considerations. Fishman, A.M. (CENTAR Assoc, Fairfield, NJ). *AIChE Symp. Ser.;* **73**: No. 169, 43-51(1977).

Description of some economic and engineering considerations of the CENTAR Associates' 3000000 SWU/yr gas centrifuge uranium enrichment plant project. The need for uranium enrichment facilities is discussed, and the advantages of using the centrifuge process rather than the presently used gaseous diffusion process are reviewed. A description of the CENTAR plant is given, highlighting the major features of the facility. Since the centiruges to be used in the plant account for approximately 50% of the capital cost of the project, the philosophy of their manufacture and procurement is discussed. Various design considerations which bear upon process economics are presented to give the reader an appreciation of the subtleties of the technology and the flexibility possible in plant design. Special attention is given to meeting the needs of the utility customer at the lowest possible cost.

34602 Garrett Nuclear Corporation gas centrifuge enrichment plant. Mikelson, F.D. (Garrett Nucl Corp, Torrance, Calif). *AIChE Symp. Ser.;* **73**: No. 169, 52-61(1977).

A description is given of the salient features of a 3000000 Separative Work Units (SWU)/yr uranium enrichment plant utilizing the gas centrifuge process. The key program accomplishments of ERDA's multicontractor gas centrifuge research and development program, which has been active since 1961, also are discussed. In addition to describing the physical and general functional features of the plant, some insight is provided as to the plant operational modes available to satisfy the complex requirements of the uranium enrichment market in a manner responsive to the utility customer's economic interests. 6 refs.

34603 Cascade of centrifugal separator. Hoshina, S.; Higashi, S.; Morokuzu, M. (to Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). Japanese Patent 1977-18,596/A/. 5 Aug 1975. 5p. (In Japanese).

A method is provided to reduce installation area of cascade in centrifugal separator and to improve separation performance of the separator by means of an effective arrangement of a plurality of ideal cascade units. Structure: A plurality of complex cascades are utilized as constructive elements, each comprising a pair of ideal cascade units arranged in reversal parallel relation to each other with condensation or recovery stages thereof being adjacent each other.

LASER EXCITATION

REFER ALSO TO CITATION(S) 35779

34604 Method of separating uranium isotopes. Ueyanagi, K.; Yamamoto, M.; Hashimoto, A.; Saito, S.; Ozaki, N. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1977-39,098/A/. 22 Sep 1975. 3p. (In Japanese).

A method is provided to permit separation of natural uranium from ^{235}U with high efficiency with a comparatively simple means making use of selective deflection of ^{235}U by laser light. In the process of selective deflection of ^{235}U a beam of uranium vapor is irradiated with light of 3507.42A which is one of laser oscillations of dihydric ions of krypton (Kr III). The wavelength of laser light is made to coincide with the absorption wavelength between the base state and energy level of 28504 cm^{-1} of ^{235}U by means of Zeeman effect produced by applying magnetic field to at least either the laser or uranium beam. In this way, the selective deflection of ^{235}U is effected to separate uranium isotopes.

34605 Separation method of uranium isotopes. Yamamoto, M.; Ueyanagi, K.; Hashimoto, A.; Saito, S.; Tomiyama, S. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1977-24,699/A/. 18 Aug 1975. 4p. (In Japanese).

A method is given to efficiently separate ^{235}U from natural uranium by means of a relatively simple device without requiring a chromolaser. Uranium vapor generated by a heating furnace is formed by a slit into a beam which arrives at a laser radiation station. A power beam and ionizing light beam of an initially exciting laser are radiated in the laser radiation station. The laser is provided with a coil so that a magnetic field is applied. The laser radiation station is also provided with a coil in the periphery thereof so that a magnetic field can be applied to the beam of U vapor passing through the radiation station. With the construction as described above, the intensity of the magnetic field formed by the coils may be controlled so that the oscillating wavelength of the laser coincides with the absorbing wavelength of ^{235}U. Thereby, only ^{235}U of U in a ground state is excited by the laser light to an intermediate level and is further excited by the ionizing light into an ionizing state.

34606 Separation method of uranium isotopes. Ueyanagi, K.; Yamamoto, M.; Hashimoto, A.; Ito, M.; Komoto, M. (to Hitachi Ltd., Tokyo (Japan)). Japanese Patent 1977-22,698/A/. 13 Aug 1975. 5p. (In Japanese).

A method is provided to relatively conveniently and efficiently separate uranium isotope by means of multistage light ion using a laser light. A wavelength of a second harmonic or a third harmonic of a laser whose active material is neodymium is used as a first stage light-exciting light source in the course of ionizing multi-stage selected light of ^{235}U, and the excited ^{235}U atom is further ionized by means of more than one light radiation so as to be separated from ^{238}U by means of an electromagnetic method. Most efficiently, Nd: $YAlO_3$ α 1.0725 μm of oscillating rays is used for laser light, and 27966 cm^{-1} of rays is used for uranium adsorbing rays.

FUELS PRODUCTION AND PROPERTIES

34607 Diffusion of plutonium in high-temperature isotropic pyrolytic carbon. Baldwin, N.L.; Winchell, P.; Langer, S. (General Atomic Co., San Diego, CA). *Nucl. Technol.;* **37**: No. 3, 353-357(Mar 1978).

The diffusion coefficient for plutonium diffusing in isotropic pyrolytic carbon has been determined as a function of temperature. The apparent diffusion coefficient can be expressed by the equation $D = 4.47 \times 10^{-8} \exp(-55\ 000/RT)\ m^2 \cdot s^{-1}$ over the temperature range from 1273 to 2073°K. Evaluation and comparison of the plutonium diffusion data with that of uranium and thorium using a compensation law treatment resulted in a reasonably good correlation, thus implying similar diffusion mechanisms. 4 figures, 2 tables.

34608 Alteration of the fabrication business at Kumatori Works of Nuclear Fuel Industries, Ltd. *Genshiryoku Iinkai Geppo;* **21**: No. 12, 5-7(Mar 1977). (In Japanese).

This is the report by the Atomic Energy Commission to the Prime Minister, and the report by the Commission on Examination on Nuclear Fuel Safety to the Atomic Energy Commission of Japan concerning the subject matter is attached. The alterations are on the facility for producing fuel (forming and fabrication) for light water reactors, especially the installation of a fuel assembly storage room, the transfer of analytical equipment, and the expansion of the storage facility for UO_2 powder, etc. The safety of the altered facility is well confirmed.

34609 Safety concerning the alteration in usage of nuclear fuel material (alteration of Plutonium Fuel Development Laboratory No. 2) at Tokai Works of Power Reactor and Nuclear Fuel Development Corporation. *Genshiryoku Iinkai Geppo;* **22**: No. 1, 2-5(Mar 1977). (In Japanese).

This is the report by the Atomic Energy Commission to the Director of Science and Technology Agency, and the report by the Committee on Examination of Nuclear Fuel Safety to the Atomic

Energy Commission of Japan concerning the subject matter is attached. The alteration of the use of fuel in the Laboratory is to produce the fuel for the irradiation core in the experimental fast reactor differing from the conventional one in dimensions, chemical composition, and Pu isotope composition, thereby entailing the alterations of the production facility. The safety of the altered facility including those for pellet production and fuel fabrication is well confirmed.

SPENT FUELS REPROCESSING

REFER ALSO TO CITATION(S) 34665, 35720, 35734

34610 (DP-MS—77-77) **Light water reactor fuel reprocessing: dissolution studies of voloxidized fuel.** Johnson, D.R.; Stone, J.A. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1977. Contract FY-76-C-09-0001. 33p. (CONF-780304—5). Dep. NTIS, PC A03/MF A01.

From ANS - The Back End of the LWR Fuel Cycle; Savannah, GA, USA (19 Mar 1978).

Voloxidation is a proposed head-end process to remove tritium from irradiated LWR fuel by roasting the fuel in the presence of oxygen. The process oxidizes UO_2 to a fine U_3O_8 powder with high surface area for dissolution. Small-scale tests with irradiated Robinson, Oconee, and Saxton reactor fuels have been made to determine the dissolution behavior of both voloxidized and nonvoloxidized (UO_2) fuel. No significant technical problems were encountered in batch-dissolving of the U_3O_8 or UO_2 fuel. Dissolution rates were well-controlled in all tests. Significant observations from U_3O_8 dissolution, when compared to UO_2 dissolution, included: (1) reduced tritium and ruthenium (^{106}Ru) concentration in dissolver solutions, (2) increased weight of insoluble noble metal fission product residue (approximately 2.2X greater), and (3) increased fraction of the total plutonium which remains insoluble and is collected with the fission product residue. The insoluble plutonium was leached easily from the residue by 10M HNO_3 to ensure quantitative plutonium recovery. The weight of the fission product residue collected from both U_3O_8 and UO_2 fuels increased linearly with fuel burnup. A major fraction (> 88%) of the ^{85}Kr was evolved from U_3O_8 fuel during dissolution rather than voloxidation. The ^{85}Kr evolution rate was an appropriate monitor of fuel dissolution rate. Virtually all of the ^{129}I was evolved by air sparging of the dissolver solution during dissolution.

34611 (DP-MS—77-81) **Clarification of LWR dissolver solutions.** Plodinec, M.J. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1978. Contract EY-76-C-09-0001. 17p. (CONF-780304—3). Dep. NTIS, PC A02/MF A01.

From ANS - The Back End of the LWR Fuel Cycle; Savannah, GA, USA (19 Mar 1978).

When high-burnup LWR fuels are reprocessed, fission products cause solids formation during solvent extraction. Several methods for clarifying LWR dissolver solutions have been evaluated. Chemical treatment as well as centrifugation will be necessary to provide clarified feed for solvent extraction. Addition of an organic flocculant is the most promising method. The best flocculant tested, Primafloc C-3, clarified dissolver solutions noticeably even at flocculant concentrations of only 0.2 ppM. Unlike observed behavior of some other flocculants, even at the highest concentration tested (8300 ppM) no redispersion or flotation of solids were observed. The standard Purex MnO_2 treatment clarified test solutions adequately, but significantly added to the solids content of the aqueous wastes. No fission product decontamination was obtained and there was evidence of dissolution of fission product PuO_2 during MnO_2 precipitation.

34612 (GA-A—14675) **Interim design report: fuel particle crushing.** Baer, J.W.; Strand, J.B.; Cook, E.J.; Miller, C.M. (General Atomic Co., San Diego, Calif. (USA)). Nov 1977. Contract EY-76-C-03-0167-053. 120p. Dep. NTIS, PC A06/MF A01.

The double-roll fuel particle crusher was developed to fracture the silicon carbide coatings of Fort St. Vrain (FSV) fertile and fissile and large high-temperature gas-cooled reactor (LHTGR) fissile fuel particles. The report details the design task for the fuel particle crusher, including historical test information on double-roll crushers for carbide-coated fuels and the design approach selected for the coid pilot plant crusher, and shows how the design addresses the equipment goals and operational objectives. Design calculations and considerations are included to support the selection of crusher drive and gearing, the materials chosen for crushing rolls and housing, and the bearing selection. The results of the initial testing for compliance with design objectives and operational capabilities are also presented. 8 figures, 4 tables.

34613 **Utility optimization model of fuel cycle back-end services.** Kaikkonen, H.; Salo, J.P.; Silvennoinen, P. (Technical Research Centre of Finland, Helsinki). *Nucl. Technol.;* **38**: No. 2, 312-320(Apr 1978).

From Conference on low-temperature nuclear heat; Otaniemi, Finland (21 Aug 1977).

Optimization of the back-end services of the fuel cycle is solved by linear programming. A mathematical model governs the flow of fissile material from the reactor to spent fuel storages, to reprocessing and/or ultimate disposal, and to the fabrication of mixed-oxide fuel. The computer program developed is amenable to the optimization of the overall material flow together with recycle schedules and capacities under the prevailing market conditions and their trends. The income tax consideration is not included in the analysis, and therefore the results are applicable mainly to government-owned power production. Using the nuclear program of Finland, calculations are made to study the break-even reprocessing costs with regard to the throwaway costs. According to our conservative price estimates, the recycle benefit amounts to some 6.4 to 6.9% as calculated from the total discounted fuel cost over the years from 1977 to 2004. Over the time period of a few years at the beginning of the plutonium recycle, the levelized costs would be lower in the throwaway case, which is contrary to the overall result.

34614 **Conceptual reprocessing and waste management scheme for Zircaloy-clad thoria fuels.** Lvine, H.S.; Schwoebel, R.L. (Sandia Labs., Albuquerque, NM). *Nucl. Technol.;* **37**: No. 3, 193-195(Mar 1978).

This simple, direct scheme depends on the use of a strong chlorinating agent to convert the zircaloy waste and adhering oxide fuel to nonvolatile chlorinated residue and volatile $ZrCl_4$ fractions. The latter would be converted to an inorganic ion exchanger and combined with HLLW to produce a stable, refractory waste form. The former would be processed to remove chloride and then recombined with the main oxide fuel process stream. (DLC)

34615 **Radiological assessment of reprocessing advanced liquid-metal fast breeder reactor fuels.** Till, J.E.; Bomar, E.S.; Morse, L.E.; Tennery, V.J. (Oak Ridge National Lab., TN). *Nucl. Technol.;* **37**: No. 3, 328-339(Mar 1978).

Results of the assessment were compared with those for reference oxide fuel. Candidate advanced fuels analyzed included [(U,Pu)C] and [(U,Pu)N] with selected concentrations of ^{15}N. Core neutronics and designs appropriate to advanced-fueled LMFBRs were used with the ORIGEN computer code to calculate compositions of spent core and blanket fuel equivalent to 50 GW-y of electrical energy generation. Confinement factors, specific to each radionuclide released to the atmosphere at the reprocessing plant, were used to calculate source terms describing the emission of radionuclides. Radiological impact within a 80-km radius of the facility was determined with the AIRDOS-II computer code, while the dose to the world population from ^{14}C released at the reprocessing plant was estimated with a multicompartment global carbon cycling model. For carbide fuel, the calculated dose commitment to the total body of the maximally exposed individual was approximately 2.8 mrem. Corresponding dose commitments when nitride fuels were substituted ranged between 59 and 3.4 mrem, as the ^{14}N content in fuel was varied from 99.64%, the natural abundance of ^{14}N, to zero (i.e., 100% enrichment with ^{15}N), respectively. Dose commitment to the world population from ^{14}C produced in nitride fuel made with natural nitrogen may prohibit use of this fuel from an environmental standpoint. However, a combination of ^{15}N enrichment in the fuel and confinement of at least part of the ^{14}C at the reprocessing plant can significantly reduce both the amount of ^{14}C ultimately released to the atmosphere and the global impact from ^{14}C. It was concluded that no major differences exist in the radiological impact when carbide fuel is substituted for oxide fuel at the reprocessing plant. The use of nitride fuel may, however, require substantial enrichment with ^{15}N or significant improvement in effluent treatment techniques proposed for ^{14}C retention. 7 tables, 5 figs, 14 refs.

34616 **Safety in alteration in part of the fuel reprocessing facility of Power Reactor and Nuclear Fuel Development Corporation.** *Genshiryoku Iinkai Geppo;* **22**: No. 2, 4-6(Apr 1977). (In Japanese).

This is the report by the Atomic Energy Commission to the Prime Minister, and the report of the Committee on Examination of Nuclear Fuel Safety to the Atomic Energy Commission of Japan concerning the subject matter is attached. The alterations are the conversion of a product uranium storage cell to a product plutonium storage cell to increase the latter capacity, and the modification of the dissolution waste gas storage system to improve the safety by replacing carbon steel with stainless steel. The safety of the altered facility is well confirmed.

TRANSPORT AND STORAGE

REFER ALSO TO CITATION(S) 34644, 35201, 35202, 35803

34617 (ORNL/TM—6192) **Logistics models for the transportation of radioactive waste and spent fuel.** Joy, D.S.; Holcomb, B.D. (Oak Ridge National Lab., Tenn. (USA)). Mar 1978. Contract W-7405-ENG-26. 54p. Dep. NTIS, PC A04/MF A01.

Mathematical modeling of the logistics of waste shipment is an effective way to provide input to program planning and long-range waste management. Several logistics models have been developed for use in parametric studies, contingency planning, and management of transportation networks. These models allow the determination of shipping schedules, optimal routes, probable transportation modes, minimal costs, minimal personnel exposure, minimal transportation equipment, etc. Such information will permit OWI to specify waste-receiving rates at various repositories in order to balance work loads, evaluate surge capacity requirements, and estimate projected shipping cask fleets. The programs are tailored to utilize information on the types of wastes being received, location of repositories and waste-generating facilities, shipping distances, time required for a given shipment, availability of equipment, aboveground storage capabilities and locations, projected waste throughput rates, etc. Two basic models have been developed. The Low-Level Waste Model evaluates the optimal transportation policy for shipping waste directly from the source to a final destination without any intermediate stops. The Spent Fuel Logistics Model evaluates the optimal transportation policy for shipping unreprocessed spent fuel from nuclear power plants (1) indirectly, that is, to an Away-From-Reactor (AFR) storage facility, with subsequent transhipment to a repository, or (2) directly to a repository.

34618 (PTB-FMRB—64) **Transport of radioactive materials, paying special attention to nuclear fuels.** Blechschmidt, M. (Physikalisch-Technische Bundesanstalt, Braunschweig (Germany, F.R.). Forschungs- und Messreaktor). Jun 1977. 22p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

The transport of radioactive materials, particularly within the nuclear fuel cycle, is of increasing importance, and is more than ever a matter of public debate. This report provides information concerning the necessary physical, technical and administrative precautions which must be taken to ensure protection of the environment. The international standard of requirements for the packing of the materials is emphasized, as in many cases, transports cross national borders. The relatively comprehensive list of references can be used for the study of details.

MARKETING AND ECONOMICS

34619 (GJO—108(77), pp 37-56) **Uranium market activities.** Patterson, J.A.; Combs, G.F. Jr. (Department of Energy, Washington, DC). 1977.

From Uranium industry seminar; Grand Junction, CO, USA (26 Oct 1977).

In Uranium industry seminar.

Data on procurement and prices and their relations with uranium requirements are reviewed. Market surveys are discussed along with uranium production activities by utilities. Total price estimates are given along with capital expenditures. (JRD)

34620 (GJO—108(77), pp 57-68) **Domestic uranium requirements.** Bown, R.W.; Williamson, R.H. (Department of Energy, Washington, DC). 1977.

From Uranium industry seminar; Grand Junction, CO, USA (26 Oct 1977).

In Uranium industry seminar.

Forecasts of domestic uranium requirements are presented. It is noted that the energy and electricity forecasts based on the National Energy Plan appear to be a good framework for determining future uranium demands. The Plan may not be enacted in its entirety at this time, but an evolving energy policy over several years that embraces the Plan's principles is essential and can be expected to be implemented. No matter how the energy future is analyzed it is clear that necessary power must play a substantial role. The administration is supporting programs to ensure that LWRs continue to be a major contributor to our energy needs. As a part of this fuel cycle activity, a strong and competitive uranium industry must be maintained. (JRD)

34621 (K-OA—2547(Pt.1)) **Survey of foreign enrichment capacity, contracting and technology: October 1972—July 1974.** Blumkin, S. (Oak Ridge Gaseous Diffusion Plant, Tenn. (USA)). 6 Sep 1974. Contract W-7405-ENG-26. 17p. Dep. NTIS, PC A02/MF A01.

Enrichment capacity plans are given for West Germany, South Africa, and two multinational organizations (the Tripartite Group and Eurodif). Sales of the separative work from projected new capacity are discussed. (LK)

34622 (K-OA—2547(Pt.2)) **Survey of foreign enrichment capacity, contracting and technology: August—October 1974.** Blumkin, S. (Oak Ridge Gaseous Diffusion Plant, Tenn. (USA)). 10 Dec 1974. Contract W-7405-ENG-26. 12p. NTIS, PC A02/MF A01.

All of the news in the August-October 1974 period in regard to foreign enrichment capacity plans report either the undertaking of feasibility studies or negotiations between nations for sharing of the funding for the construction of enrichment plants under consideration. A summary of commitments to deliver enriched uranium is presented. (LK)

34623 (K-OA—2547(Pt.3)) **Survey of foreign enrichment capacity, contracting and technology: November 1974—December 1975.** Blumkin, S. (Oak Ridge Gaseous Diffusion Plant, Tenn. (USA)). 5 Mar 1976. Contract W-7405-ENG-26. 52p. Dep. NTIS, PC A04/MF A01.

A summary is presented of enrichment plans, commitments to deliver enriched uranium, and research development plans for the November 1974 through December 1975 period. (LK)

34624 (K-OA—2547(Pt.4)) **Survey of foreign enrichment capacity, contracting and technology: January 1976—December 1976.** Blumkin, S. (Oak Ridge Gaseous Diffusion Plant, Tenn. (USA)). 18 Apr 1977. Contract W-7405-ENG-26. 52p. Dep. NTIS, PC A04/MF A01.

News of plans to build enrichment facilities, of commitments to deliver enriched uranium, and of programs for research and development are reviewed briefly. (LK)

WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 34660, 35725

34625 (KFK—2380) **Annual report 1975.** Krause, H. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Abt. zur Behandlung Radioaktiver Abfaelle). Dec 1976. 224p. (In German). Dep. NTIS (US Sales Only), PC A10/MF A01.

In 1975 R+D-work of the Waste Management Research Department (ABRA) essentially covered the following fields: 1) Solidification of high-level fission product solutions and liquid α-wastes into borosilicate glasses. 2) Treatment of medium-level aqueous and organic waste solutions from reprocessing plants. 3) Incorporation of low and medium level waste concentrates into bitumen. 4) Wet combustion of solid plutonium-bearing wastes. 5) Decontamination of equipment. 6) Development of nuclear equipment for the transport and for final disposal of radioactive wastes in the Asse salt mine. 7) Investigations relating to the nuclear safety of final disposal of radioactive wastes in the Asse salt mine. 8) Actinide migration in soils. This report gives a survey of the main results obtained.

34626 **Nuclear wastes as a heat source.** Witzig, W.F.; Foster, M.E. (Pennsylvania State Univ., University Park). *Nucl. Technol.;* **38**: No. 2, 258-263(Apr 1978).

From Conference on low-temperature nuclear heat; Otaniemi, Finland (21 Aug 1977).

The concept of utilizing processed fission product wastes as a heat source to produce low-pressure steam in a nuclear waste boiler (NWB) has been analyzed. The conceptual NWB design utilizes solidified wastes from spent fuel reprocessing plants in a natural circulation boiler that is sectionalized to permit continuous operation during refueling. Any one of several proposed commercial solidification processes provides wastes in a containerized form suitable, without modification, to be used in this concept. The NWB is analyzed in terms of its fuel cycle, design, safety, and economic potential. It is competitive with fossil plants of similar capacity in limited applications when substantial quantities of waste are available.

34627 **Quantities of radioactive wastes from nuclear fuel cycle.** Ikari, K. (Japan Atomic Energy Research Inst., Tokyo); Matsumoto, A. *Genshiryoku Kogyo;* **23**: No. 4, 15-21(Apr 1977). (In Japanese).

Radioactive wastes result more or less from the nuclear fuel cycle of mining, refining, enrichment, fuel fabrication, power generation, and fuel reprocessing. The quantity generated in each stage is obtained as the product of the quantity per unit operation and facility operation. These radioactive wastes are treated and disposed of so that they will not affect the livelihood environment of the humanity. Treatment is divided in two steps, i.e. volume reduction and packaging. The final amounts of radioactive waste packages can be calculated by the following procedure: setting up the suitable means of treamtment for respective types of wastes, and multiplication of the volume reduction ratio and the volume increase ratio in packaging. Under the assumptions of fuel cycle, facility operation and waste treatment and on the basis of the up-to-date information, the quantities of radioactive waste packages up to A.D.2000 are estimated.

34628 Radioactive waste management and regulation. Willrich, M.; Lester, R.K.; Greenberg, S.C.; Mitchell, H.C.; Walker, D.A. New York; Free Press (1977). 146p. .

Purpose of this book is to assist in developing public policy and institutions for the safe management of radioactive waste, currently and long term. Both high-level waste and low-level waste containing transuranium elements are covered. The following conclusions are drawn: the safe management of post-fission radioactive waste is already a present necessity and an irreversible long-term commitment; the basic goals of U.S. radioactive waste policy are unclear; the existing organization for radioactive waste management is likely to be unworkable if left unchanged; and the existing framework for radioactive waste regulation is likely to be ineffective if left unchanged. The following recommendations are made: a national Radioactive Waste Authority should be established as a federally chartered public corporation; with NRC as the primary agency, a comprehensive regulatory framework should be established to assure the safety of all radioactive waste management operations under U.S. jurisdiction or control; ERDA should continue to have primary government responsibility for R and D and demonstration of radioactive waste technology; and the U.S. government should propose that an international Radioactive Waste Commission be established under the IAEA. (DLC)

WASTE PROCESSING

REFER ALSO TO CITATION(S) 34614

34629 (JAERI-M—6958) **Separation of radioisotopes from fuel reprocessing waste.** Nakamura, H.; Kubota, M.; Tachimori, S.; Yamaguchi, I.; Sato, A. (Japan Atomic Energy Research Inst., Tokyo). Mar 1977. 40p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

The technology development of radioisotope production from fuel reprocessing high level wastes in Radioisotope Production Division is described. To develop the separation method for partitioning as the waste management and production of useful radioisotopes, the separation of ^{90}Sr, ^{137}Cs and rare earth elements by solvent extraction and ion-exchange has been mainly studied. Ion-exchange resin and HDEHP as the extracting agents were irradiated with a ^{60}Co radiation source to examine their radiation resistances; both are satisfactory in this respect. Strontium-90 and ^{137}Cs could be separated in 99% purity from a 10l waste solution (about 2 Ci) by ion-exchange using nitric acid as the only eluant. A system of solvent extraction and ion-exchange to treat large volume of the waste was constructed in trial, and its cold test was carried out. The results were satisfactory, with a few points for further improvement. The scheme as it is can be scaled up for an experiment with about 1 KCi of the waste.

34630 (KFK—2427) **Solidification of high-level fission products by a thermite reaction. Pt. 2. Tests in a pilot plant.** Rudolph, G.; Gebauer, R.; Hild, W. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Abt. zur Behandlung Radioaktiver Abfaelle; Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Wiederaufarbeitung und Abfallbehandlung). Mar 1977. 25p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

The laboratory tests described in Part I of this report (KFK-2322) on the solidification of fission products in the product of a thermite reaction between aluminium and manganese dioxide in the presence of silicon dioxide were performed on a larger scale. A pilot facility was erected for this purpose with a furnace to preheat the crucible, a metering device, and an exhaust air purification system as the main components. In a typical test an ignitable mixture of manganese dioxide and silicon is ignited in a graphite crucible and subsequently 16 kg of the reaction mixture are metered in. The smoke generated during the reaction is carried away by an air current and deposited in a filter filled with glass wool. In a number of tests preparations were used which contained 25 wt.% of simulated fission product oxides as a fully calcinated oxide mixture or of a product from a spray calciner with some nitrate left. The rate of addition was up to 1 kg per minute, slightly less for the nitrate bearing preparations. Under the conditions of testing the reaction products do not reach exactly the same homogeneity as in laboratory tests. Improvements can certainly be realized by use of other crucible shapes. A comparison of the advantages and disadvantages of the thermite method shows that the potential of development of this method of solidification has not yet been fully utilized.

34631 (MLM—2448) **Evaluation of ultrafiltration membranes for treating low-level radioactive contaminated liquid waste.** Koenst, J.W.; Roberts, R.C. (Mound Facility, Miamisburg, Ohio (USA)). 31 Mar 1978. Contract EY-76-C-04-0053. 13p. Dep. NTIS, PC A02/MF A01.

A series of experiments were performed on Waste Disposal Facility (WD) influent using Romicon hollow fiber ultrafiltration modules with molecular weight cutoffs ranging from 2000 to 80,000. The rejection of conductivity was low in most cases. The rejection of radioactivity ranged from 90 to 98%, depending on the membrane type and on the feed concentration. Typical product activity ranged from 7 to 100 dis/min/ml of alpha radiation. Experiments were also performed on alpha-contaminated laundry wastewater. Results ranged from 98 to >99.8%, depending on the membrane type. This yielded a product concentration of less than 0.1 dis/min/ml of alpha radiation. Tests on PP-Building decontamination water yielded rejections of 85 to 88% alpha radiation depending on the membrane type. These experiments show that the ability to remove radioactivity by membrane is a function of the contents of the waste stream because the radioactivity in the wastewater is in various forms: ionic, polymeric, colloidal, and absorbed onto suspended solids. Although removal of suspended or colloidal material is very high, removal of ionic material is not as effective. Alpha-contaminated laundry wastewater proved to be the easiest to decontaminate, whereas the low-level PP-Building decontamination water proved to be the most difficult to decontaminate. Decontamination of the WD influent, a combined waste stream, varied considerably from day to day because of its constantly changing makeup. The WD influent was also treated with various substances, such as polyelectrolytes, complexing agents, and coagulants, to determine if these additives would aid in the removal of radioactive material from the various wastewaters by complexing the ionic species. At the present time, none of the additives evaluated has had much effect; but experiments are continuing.

34632 (MLM—2498) **Volume reduction system for solid and liquid TRU waste from the nuclear fuel cycle: July—September 1977.** Luthy, D.F.; Bond, W.H. (Mound Facility, Miamisburg, Ohio (USA)). 6 Feb 1978. Contract EY-76-C-04-0053. 12p. Dep. NTIS, PC A02/MF A01.

Laboratory equipment is being assembled for the investigation of unusual particulate and gaseous radioactive material in the incinerator offgas when commercial wastes are incinerated. This equipment will constitute a bench-scale incinerator system with monitoring equipment to effect the investigation. A literature search was made to determine the current technology used in removing the expected effluents from gas streams. A series of controlled-feed incinerator runs was performed to determine the mass balance of chloride in the Cyclone incinerator system. Approximately 74% of the chloride present in the feed material was found to be in the scrubber solution, 8% in the flue gas, and the remaining chloride was distributed in the ash and retained in the system. A conceptual design was prepared and modifications were begun on a glove box which is to be used for the demonstration phase of incinerator ash immobilization. Concrete and cold-pressed pellets are being studied and compared for ash immobilization.

34633 (MLM—2499) **Development of ultrafiltration and inorganic adsorbents for reducing volumes of low-level and intermediate-level liquid waste: July—September 1977.** Koenst, J.W.; Herald, W.R.; Roberts, R.C. (Mound Facility, Miamisburg, Ohio (USA)). 9 Feb 1978. Contract EY-76-C-04-0053. 11p. Dep. NTIS, PC A02/MF A01.

The ultrafiltration (UF) pilot system is being evaluated at Mound Facility. The effect of pressure drop, temperature, and pH of the feed on system performance has been studied. The system has been run through a number of cleaning cycles including tap water flush, enzyme soak, detergent wash, and citric acid/oxalic acid wash. A continuous run was started on waste from the Waste Processing Facility; about 11,500 gal has been processed. Studies to determine the effect of (α, β, and γ) radiation on membrane characteristics were initiated. The small laboratory column tests were completed. Isotherms were run on several inorganic adsorbents, including titanium phosphate and sodium titanate. Tests were continued on the Engineering Test Ion Exchange System. Waste solution from the Waste Processing Facility spiked with plutonium-238 and ultrafiltration product spiked with uranium-233 were used as feeds. 6 tables, 1 figure.

34634 (RFP—2774) **Chemical research at Rocky Flats.** Navratil, J.D. (Atomics International Div., Golden, Colo. (USA). Rocky Flats Plant). 27 Feb 1978. Contract EY-76-C-04-3533. 36p. Dep. NTIS, PC A03/MF A01.

An overview of the research projects in the Chemical Research group will be given. The work involves actinide waste and processing chemistry, separations chemistry, radiation studies, and calorimetry and thermodynamics. Details will be given of the actinide separations research, including work with macroreticular anion exchangers and bidentate organophosphorus extractants.

34635 (BNWL-tr—299) **1975 annual report of the Department of Radioactive Waste Disposal of the Karlsruhe Nuclear Research Center.** Krause, H. (Kernforschungszentrum Karlsruhe (Germany, F.R.)). Mar 1978. Translation of KFK—2380, Dec 1976. 149p. Dep. NTIS, PC A07/MF A01.

Portions of document are illegible.

The status of the following studies is given: inactive laboratory tests on vitrification of highly active fission products; the

influence of alpha radiation on highly active glasses; solidification of highly active fission-product solutions; solidification of highly active wastes by thermite processes; separation of calcine in the VERA process and in a separate filter stage; melting of borosilicate-glass blocks in an electrode-heated ceramic melting system; and heat and mass transfer between the atomized drops of fission-product solution and the 450°C steam atmosphere of the VERA calciner. (LK)

34636 Catalytic trapping of methylradioiodide by beds of impregnated charcoal. Deitz, V.R. (Naval Research Lab., Washington, DC); Jonas, L.A. *Nucl. Technol.;* **37**: No. 1, 59-64(Jan 1978).

The trapping or retention efficiency of impregnated charcoal beds for the vapor of methylradioiodide tagged with ^{131}I was determined under various flow conditions by radioactive counting of each of eight equal-volume segments of the bed, including that of the large backup section. The trapping was catalytic in nature and obeyed first-order kinetics. Over a ten-fold change in residence time, the rate constant increased nonlinearly with increase in superficial linear velocity in accordance with theory.

34637 Method to avoid disturbances in the solidification of radioactive liquid wastes. Saidl, J.; Hild, W. (to Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (Germany, F.R.)). German(FRG) Patent 2,553,569/A/. 8 Jun 1977. 10p. (In German).

In the solidification of radioactive waste liquids containing boron compounds in a glass or glassceramic matrix or a bitumen or plastic matrix, the high water vapour volatility of H_3BO_3 leads to disturbances in the process: The necessary addition of glass-forming B_2O_3 in the form of ortho-boric acid for a boro-silicate matrix, in almost quantitatively impoverished during drying and calcination as a result of the high water vapour volatility, which amongst other things results in a changed glass composition. During the vaporation process this volatility leads to boric acid deposits. According to the invention, this is prevented by the addition of a borate ion capturing agent transfering into a hardly soluble boron compound (e.g. an alkali earth compound, preferably a hydroxide) and/or by a hardly soluble boron compound itself (e.g. calcium metaborate) to the radioactive waste water or concentrate or slurry.

34638 Method for ultimate storage of radioactively contaminated filter cartridges or filter elements. Puthawala, A.; Hoffmann, L.; Wille, H. (to Kraftwerk Union A.G., Muelheim an der Ruhr (Germany, F.R.)). German(FRG) Patent 2,546,428/A/. 21 Apr 1977. 7p. (In German).

A method is described for the ultimate storage of slightly to medium radioactively contaminated filter cartridges or elements. The filter cartridges are at first subjected to a drying process in the drums provided for ultimate storage at a temperature of 100 to 200°C - preferably 130 to 160°C - and then covered by hot bitumen, the pouring process extending over 30 minutes or more. Preferably the pouring process will occur in two stages, 5 to 25% of the bitumen being poured in the second stage after an interval of 30 minutes or more. In this way shrinking of the bitumen during the cooling down process, leading to undesired cavities, is accounted for and residues of moisture may escape in the form of bubbles.

34639 Safety in alteration of the usage of nuclear fuel material (alteration of the RI production building) at Tokai Research Establishment of Japan Atomic Energy Research Institute. *Genshiryoku Iinkai Geppo;* **22**: No. 2, 2-4(Apr 1977). (In Japanese).

This is the report by the Atomic Energy Commission to the Director of Science and Technology Agency, and the report by the Committee on Examination of Nuclear Fuel Safety to the Atomic Energy Commission of Japan concerning the subject matter is attached. The alteration is concerned with the increase of the quantity of fuel-reprocessing waste liquid handled in the general-purpose cave from maximum 80 to 3,000 curies, and for enabling the separation of alpha emitters, involving the modification of the cave, the installation of storage tanks below the cave, and the installation of a filter exclusively used for the cave. The safety of the altered building is well confirmed.

34640 Processing of radioactive waste solution with zeolites. II. Acid resistance of zeolites and leachabilities of Cs and Sr from calcined natural zeolites. Mimura, H.; Kanno, T. (Tohoku Univ., Sendai (Japan). Research Inst. of Mineral Dressing and Metallurgy). *Nippon Genshiryoku Gakkaishi;* **19**: No. 3, 170-176(Mar 1977). (In Japanese).

Acid resistance of zeolites in HNO_3 solution were studied at 25°C by means of X-ray powder diffraction. The structure of zeolite A (Si/Al=1.0) and X (Si/Al=1.25) began to collapse by treatment with 0.1 M HNO_3 and that of mordenite (Si/Al=5) began to collapse by treatment with 1 M HNO_3. Thermal transformations of Na, Cs and Sr type clinoptilolites were studied by means of differential thermal analysis (DTA), thermogravimetric analysis (TGA) and X-ray powder diffraction. Their structures collapsed above about 900°C and did not recrystallize until 1,400°C. Leachabilities of Cs and Sr from the calcined clinoptilolite and mordenite saturated with Cs and Sr decreased as the calcining temperature rose. Especially, the leaching rates of Cs from clinoptilolite and mordenite calcined at 1,200°C for 3 hr were under 10^{-9} g/cm^2.day. This value was under 1/10 of the leaching rates from zeolites calcined at 1,100°C. The leaching rates of Sr from clinoptilolite and mordenite calcined at 1,100°C for 3 hr were about 10^{-9}g/cm^2.day. The surface area of calcined zeolites used in this calculation was measured by N_2 gas adsorption method.

34641 Method for solidifying liquid wastes containing radioactive or toxic material. Knieper, J.; Printz, H.; May, K. (to Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.)). German(FRG) Patent 2,531,056/A/. 20 Jan 1977. 9p. (In German).

When aqueous solutions containing radioactive or toxic waste are solidified disturbing heat production or effervescence often occurs. This can be avoided if to such solutions, which may have a relatively high acid or alkali content, a mixture of calcium sulfate and a porous solid substance (e.g. broken stone from ceramic bricks) is added. Mixing ratio solid/liquid is given as 0.7 to 1.3 kg for 500 ml, calcium sulfate to the addition is 1 in about 0.5 to 3. The mixing should take place in stirrers. For calcium sulfate and the addition material exact criteria are given.

34642 Method for disposing radioactive resin wastes and the appropriate device. Puthawala, A.; Hoffmann, L.; Emmert, H.; Hild, W.; John, H.E.; Kluger, W. (to Kraftwerk Union A.G., Muelheim an der Ruhr (Germany, F.R.)). German(FRG) Patent 2,531,584/A/. 20 Jan 1977. 11p. (In German).

It is proposed to dry radioactive resin waste from nuclear power plants, especially ion exchanger filter material, completely by means of warm air and only then to convey it through a dosing device to a kneader, where it is mixed with bitumen at 120°C. The mixture then is filled into containers and delivered for off-site ulitmate storage. The device is described in detail.

WASTE DISPOSAL AND STORAGE

REFER ALSO TO CITATION(S) 34635, 35080

34643 (DP-MS—77-115(Rev.)) **Compatibility testing of vitrified waste forms.** Rankin, W.N. (Savannah River Ecology Lab., Aiken, S.C. (USA)). 6 Mar 1978. Contract EY-76-C-09-0001. 26p. (CONF-780308—7). Dep. NTIS, PC A03/MF A01.

From NACE meeting on corrosion; Houston, TX, USA (6 Mar 1978).

An experimental program to evaluate candidate metals for use in the fabrication of canisters for long-term storage of vitrified radioactive wastes is described. The long-term compatibility of the candidate metal both with the contained vitrified radioactive waste and with the external environments expected in possible final storage locations will be determined. These tests involve heating combinations of waste forms and canister metals in intimate contact for up to 50,000 hr to accelerate any reactions that occur.

34644 (ORNL/ENG/TM—7) **Prediction of temperature increases in a salt repository expected from the storage of spent fuel or high-level waste.** Llewellyn, G.H. (Oak Ridge National Lab., Tenn. (USA)). Apr 1978. Contract W-7405-ENG-26. 83p. Dep. NTIS, PC A05/MF A01.

Comparisons in temperature increases incurred from hypothetical storage of 133 MW of 10-year-old spent fuel (SF) or high-level waste (HLW) in underground salt formations have been made using the HEATING5 computer code. The comparisons are based on far-field homogenized models that cover areas of 65 and 25 sq miles for SF and HLW, respectively, and near-field unit-cell models covering respective areas of 610 ft^2 and 400 ft^2. Preliminary comparisons based on heat loads of 150 kW/acre and 3.5 kW/canister indicated near-field temperature increases about 20% higher for the storage of the spent fuel than for the high-level waste. In these comparisons, it was also found that the thermal energy deposited in the salt after 500 years is about twice the energy deposited by the high-level waste. The thermal load in a repository containing 10-year-old spent fuel was thus limited to 60 kW/acre to obtain comparable far-field thermal effects as obtained in a repository containing 10-year-old high-level waste loaded at 150 kW/acre. Detailed far-field and unit-cell comparisons of transient temperature increases have been made based on these loadings. Unit-cell comparisons were made between a canister containing high-level waste with an initial heat production rate of 2.1 kW and a canister containing a PWR spent fuel assembly producing 0.55 kW. Using a three-dimensional unit-cell model, a maximum salt temperature increase of 260°F was calculated for the high-level waste prior to back-filling (5 years after burial), whereas a maximum temperature increase of 110°F was calculated for the spent fuel prior to backfilling (25 years after burial). Comparisons were also made between various configurational models for the high-level waste showing the applicability of each model.

34645 (ORNL/TM—5462) **Interim report on development of a semi-empirical numerical model for simulating the deformational behavior of a high-level radioactive waste repository in bedded salt.** Crouch, S.L.; McClain, W.C. (Oak Ridge National Lab., Tenn. (USA)). Apr 1978. Contract W-7405-ENG-26. 82p. Dep. NTIS, PC A05/MF A01.

This report describes a computer model for simulating the deformational behavior of the rock surrounding a high-level radioacive waste repository in a bedded salf formation. The model assumes that the rock mass is isotropic and linearly elastic. It also assumes that all nonlinear, inelastic effects are confined to a single seam, or salt bed, where deformations are related to time, stress, and temperature. Because of the assumed linear behavior of the rock, superposition is used to analyze the repository problem in terms of three interrelated pheonmena: (1) elastic closure of the excavated areas with consequent elastic deformation of the rock mass; (2) time-, stress-, and temperature-dependent closure of the unmined portions of the seam; and (3) thermal stress and displacement changes throughout the rock mass, including the seam, where stress and temperature variations affect the creep behavior of the seam material. The computer model is based on the displacement discontinuity method of analysis, in which the seam is treated as a number of individual displacement discontinuities (or dislocations) whose values are determined such that the appropriate boundary conditions are satisfied at the plane of the repository. The boundary conditions, in turn, are governed by the overburden stress, the thermal stress, and temperature changes caused by the decay of the radioactive wastes and the inelastic behavior of the salt in the seam. The radioactive waste is modeled as a series of heat sources with specified heat generation characteristics. The creep deformation of the seam is computed from a creep law whose form was derived from laboratory model pillar tests; the parameters for the creep law were established from full-scale field data obtained from the Project Salt Vault experiment.

34646 (PNL—2480) **Ultrasonic inspection techniques for two weld closures proposed for RSSF waste storage casks.** Doctor, S.R.; Morris, C.J. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jan 1978. Contract EY-76-C-06-1830. 28p. Dep. NTIS, PC A03/MF A01.

One method being considered for interim storage of high-level radioactive waste materials is to place these materials in large sealed stainless steel canisters and subsequently store these canisters in a second sealed steel storage cask. Weld procedures are proposed as the closure or seal for these vessels. Inspection of these closures to assure initial and long-term integrity of the closure welds presents a challenge to nondestructive testing. The environment is thermally (400 to 1000°F) and radioactively (10^5 R/hr) hot necessitating remote inspection procedures. As a result of research work, ultrasonic test techniques were developed for inspecting the final weld closure of the waste cask. Special transducers, coupling techniques and fixturing were developed and demonstrated in a mockup test facility by remotely examining a 2-in. full penetration weld closure. The examination was performed at room ambient and at a temperature of 200°F. Testing at the desired temperature of 400°F was not completed due to a loss in transducer performance at temperatures in excess of 200°F. Upon completion of the mockup test demonstration, the cask was subjected to a drop test. The ultrasonic results of the pre- and post-examination of two weld closures (the 2-in. full penetration weld and the threaded plug with seal weld) are presented. After the completion of the drop test, both weld closures were radiographed. The radiographs verified the ultrasonic examination and the presence of weld defects in the same areas. Sectioning of the cask closure welds with metallographic verification was not completed at the time of this writing. As a result of the experience gained from the Retrievable Surface Storage Facility (RSSF) storage cask program, recommendations pertaining to the nondestructive engineering development program for Spent Unreprocessed Fuel (SURF) storage casks are presented.

34647 (RHO-BWI—78-100-FEB) **Basalt Waste Isolation Program: monthly report.** Deju, R.A. (Atomics International Div., Richland, Wash. (USA). Rockwell Hanford Operations). 28 Feb 1978. Contract EY-77-C-06-1030. 25p. Dep. NTIS, PC A02/MF A01.

20 square miles were mapped in the Saddle Mountains immediately north of Hanford. Twenty-six gravel pits within and adjacent to Hanford were given preliminary characterization and no tectonically induced structures were found. Approximateiy 1,800 wells have been identified in the Pasco Basin which penetrate basalt. In the Waste/Basalt Interaction area, progress continued in isolating those interaction products which are primary hosts for various cations and anions. Hydrologic Hole DC-5 was completed at 3,990 feet on Feb. 9. Mine modeling studies showed that at depths of 3,000 feet, the probability of joint slip above the plane of the respository is very small.

34648 (RHO-BWI—78-100-JAN) **Basalt Waste Isolation Program: monthly report.** Deju, R.A. (Atomics International Div., Richland, Wash. (USA). Rockwell Hanford Operations). 31 Jan 1978. Contract EY-76-C-06-1030. 25p. Dep. NTIS, PC A02/MF A01.

40 square miles were geologically mapped in the vicinity of Hanford. In the hydrologic program, testing procedures were established and preparation initiated to develop the tools needed for field testing. The waste/basalt interaction studies continued. The hydrothermal treatment experiments involving simulated waste-glass spheroids were conducted to determine the extent of alteration products. Large-volume reconnaissance experiments utilizing spent unreprocessed fuel, Hanford water, and actual basalt samples were initiated. Hydrologic Hole DC-5 was completed just below 3,500 feet. Cable tool operations at DC-8 were progressing normally, with a depth at the end of the reporting period of 428 feet. Core Hole DC-11 at Gable Mountain was completed Jan. 10 at a total depth of 385 feet. Core Hole DC-6 now has casing cemented to 1,100 feet and is being cored at 1,200 feet.

34649 (RHO-ST—8) **Environmental factors needed to establish the geotechnical feasibility of storing radioactive waste in Columbia River basalt.** Deju, R.A.; Eddy, P.A.; Grutzeck, M.W.; Myers, C.W. (Atomics International Div., Richland, Wash. (USA). Rockwell Hanford Operations). Sep 1977. Contract EY-77-C-06-1030. 116p. Dep. NTIS, PC A06/MF A01.

The geotechnical program required to fully establish the feasibility of storing commercial radioactive waste in Columbia River Basalt is a complex interdisciplinary effort. This report details the program required to establish the feasibility of storing radioactive waste in this basalt. The program includes: (1) achieving an understanding of the geologic setting; (2) appropriately defining the extent of hydrologic isolation of the storage mode; and, (3) evaluating the extent of chemical compatibility between radioactive waste and basalt. Work in areas (1) and (2) will be conducted sequentially as part of a generalized survey which will allow us to make a detailed site evaluation. Work in area (3) will be carried out concurrently allowing us to assess the magnitude of the interactive processes and evaluate the containment properties of basalt. All these data will ultimately allow us to design and construct an underground repository. The plan was prepared after careful study of numerous references (see Bibliographies), which represent many man-years of effort in the areas of geology, hydrology, fracture flow systems, and radioactive waste/basalt compatibility. This report also presents a synopsis of what is known about the geology and hydrology of the Columbia Plateau and the studies to date on radioactive waste/basalt compatibility. The program outlined in this report should serve as a valuable guide as work progresses and as a basis for environmental assessment once all needed factors have been measured and interpreted.

34650 (UCRL—13815) **Estimation of the statistical distribution of faulting in selected areas and the design of an exploration model to detect these faults. Final research report.** Brooke, J.P. (San Jose State Univ., Calif. (USA). Dept. of Geology). Nov 1977. Contract W-7405-ENG-48. 93p. Dep. NTIS, PC A05/MF A01.

Selected sites in the United States have been analyzed geomathematically as a part of the technical support program to develop site suitability criteria for High Level Nuclear Waste (HLW) repositories. Using published geological maps and other information, statistical evaluations of the fault patterns and other significant geological features have been completed for 16 selected localities. The observed frequency patterns were compared to theoretical patterns in order to obtain a predictive model for faults at each location. In general, the patterns approximate an exponential distribution function with the exception of Edinburgh, Scotland--the control area. The fault pattern of rocks at Edinburgh closely approximate a negative binominal frequency distribution. The range of fault occurrences encountered during the investigation varied from a low of 0.15 to a high of 10 faults per square mile. Faulting is only one factor in the overall geological evaluation of HLW sites. A general exploration program plan to aid in investigating HLW respository sites has been completed using standard mineral exploration techniques. For the preliminary examination of the suitability of potential sites, present economic conditions indicate the scanning and reconnaissance exploration stages will cost approximately $1,000,000. These would proceed in a logical sequence so that the site selected optimizes the geological factors. The reconnaissance stage of mineral exploration normally utilizes "saturation geophysics" to obtain complete geological information. This approach is recommended in the preliminary HLW site investigation process as the most economical and rewarding. Exploration games have been designed for potential sites in the eastern and the western U.S. The game matrix approach is recommended as a suitable technique for the allocation of resources in a search problem during this preliminary phase.

34651 (Y/OWI/SUB—77/22303/8) **Summary of conceptual repository analyses and evaluations and in situ heater experiments for FY 1977. Project summary report RSI-0060.** Callahan, G.D. (RE/SPEC, Inc., Rapid City, S.Dak. (USA)). 21 Nov 1977. Contract W-7405-ENG-26. 33p. Dep. NTIS, PC A03/MF A01.

Several tasks were completed and initiated relative to various aspects of the National Terminal Waste Storage Program. The specific tasks, involving generally rock mechanics efforts, included analytical/numerical simulations of repository concepts utilizing the finite-element method, quasi-static and creep testing of laboratory specimens, and in situ experimentation. The major portion of the overall work effort has been devoted to the analytical/numerical simulations with the laboratory testing program acting as a support facility in developing material properties and constitutive relations from various salt formations. The analysis efforts have involved a parametric scoping of the global temperature fields and the potential for global thermal fracturing around repository facilities. Further analysis activities involved an extension of previous work related to the structural analysis of progressively mined solution cavities, completion of the simulation of the structural behavior of the Daamond Crystal Salt Company/Jefferson Island Mine, and assessing short-term room closures for repository configurations in salt. Each of the above analysis efforts were, in general, evaluated in conjunction with rock properties data obtained through the laboratory testing program. The major work effort regarding the in situ testing has involved planning and equipment procurement.In view of overall supportive activities, time and effort was expended in developing laboratory data acquisition systems; fabricating additional creep testing equipment; generating users manuals for the finite-element computer codes to complement their earlier documentation; and hosting a workshop/review meeting for modeling subcontractors and interested parties for the Office of Waste Isolation (OWI).

34652 (Y/OWI/SUB—4112/37) **Investigation of the utility of Gulf Coast salt domes for the storage or disposal of radioactive wastes.** Martinez, J.D.; Thoms, R.L.; Smith, C.G. Jr.; Kolb, C.R.; Newchurch, E.J.; Wilcox, R.E. (Louisiana State Univ., Baton Rouge (USA). Inst. for Environmental Studies). 30 Sep 1977. Contract W-7405-ENG-26. 524p. Dep. NTIS, PC A22/MF A01.

A summary of findings and recommendations on tectonic stability and hydrologic stability is given. Geomechanics, geohydrology, regional hydrology, and quaternary studies are discussed. (LK)

34653 (Y/OWI/SUB—4269/23) **Pressure—temperature creep testing as applied to a commercial rock salt.** Dropek, R.K.; Wawersik, W.R. (Utah Univ., Salt Lake City (USA)). Jun 1976. Contract W-7405-ENG-26. 119p. Dep. NTIS, PC A06/MF A01.

A triaxial compression apparatus was evaluated in its performance of quasi-static and creep experiments on rock salt under confining pressures to 5000 psi and temperatures to 200°C. Included is the capability to measure both axial and lateral (radial) deformation. Based on empirical data fits of the form epsilon = at/sup eta/, the observed 10 hour to 100 hour creep rates and the projected 1 year creep rates, epsilon$_1$, were in the order of 10^{-6} to 10^{-8} s^{-1}. For the most part the principal strain ratios, absolute value of epsilon$_3$/epsilon$_1$, or the ratio of the principal strain rates lay between .37 and .6 suggesting volume changes during creep which are relatively small compared with the changes in shear strain and shear strain rates. Beyond these general observations no specific trends could be identified concerning, for example, the effects of pressure, deviator stress and even temperature. This is due to gross data scatter on one hand and to insufficient number of data points for meaningful statistical analyses on the other.

34654 (Y/OWI/TM—45/1) **Office of Waste Isolation progress report, October 1976.** (Union Carbide Corp., Oak Ridge, Tenn. (USA). Office of Waste Isolation). 1 Nov 1977. Contract W-7405-ENG-26. 37p. Dep. NTIS, PC A03/MF A01.

Progress of the National Waste Terminal Storage program is reported under: technical projects, facility projects, systems projects, and regulatory affairs. Various media (salt, shales, rocks) for geologic storage are covered. (DLC)

34655 Waste disposal by shale fracturing at ORNL. Weeren, H.O. (Oak Ridge National Lab., Tenn. (USA)). *Nucl. Eng. Des.;* **44**: No. 2, 291-300(Nov 1977).

The shale fracturing process is a method of waste disposal currently in use at the Oak Ridge National Laboratory (ORNL) for the permanent disposal of locally generated intermediate-level waste solutions. In this process, the waste solution is mixed with a solids blend of cement and other additives; the resulting grout is injected into an impermeable shale formation at a depth of 700-1000 ft. A few hours after completion of the injection the grout sets, fixing the radioactive waste in the shale formation. The operational experience with this process since 1966, the monitoring techniques that have been developed, and some considerations of the impact on the environment are discussed.

34656 Disposal of radioactive wastes in geological formations. Jaeckli, H. (Ecole Polytechnique Federale, Zurich, Switzerland). *Bull. Schweiz. Elektrotech. Ver.;* **68**: No. 19, 1016-1020(1 Oct 1977). (In French).

Systematic studies conducted in Switzerland in connection with the Swiss nuclear energy program are reported. These include exploratory drillings in 6 localities.

34657 Evaluation of the radioactive wastes disposal into the deep ocean. Aoyama, I.; Yamamoto, M.; Inoue, Y. (Kyoto Univ. (Japan). Faculty of Engineering). *Health Phys.;* **33**: No. 3, 227-240(Sep 1977).

A hazard assessment for deep sea disposal of low level radioactive solid wastes which originate from nuclear power reactors in Japan is presented. The model takes account of leaching characteristics of radionuclides from wastes solidified with cement, which has not been considered in other papers. Maximum and average concentrations of radionuclides in an upper mixed layer of the sea are estimated and maximum doses for individual and population doses for Japanese people are calculated. In order to evaluate an uncertainty of parameters in the model, a sensitivity analysis was performed. The discussions include: which parameter in an equation of the model affects most the average concentration of radionuclides in the upper mixed layer and, to what degree the fluctuation of parameters due to the variation of environmental factors affects the concentration. Generally, the most sensitive parameter is the depth of the seas where the solidified wastes would be deposited. The concentration of radionuclides in the surface water is not sensitively affected by the vertical diffusion coefficient.

34658 Role of large research establishments in constructing plants for the disposal of nuclear waste. Bohm, H. (Kernforschungszentrum Karlsruhe (Germany, F.R.)). *Schweiz. Bauztg.;* **95**: No. 24, 372-378(16 Jun 1977). (In German).

Development work on waste disposal is discussed at an introductory level intended to allay unnecessary fears. Topics treated are: the nuclear fuel cycle, reprocessing spent fuel rods to retrieve uranium oxide and plutonium rods, methods of waste treatment and final storage. The volume of radioactive waste produced annually from nuclear power stations is discussed and emphasis given to current and future work on safety in disposal and reprocessing and the roles of R and D institutes and governments.

34659 Report on the environmental safety evaluation in sea disposal of radioactive wastes. *Geochem. J. (Nagoya);* No. 91, 1-35(Dec 1976). (In Japanese).

In October 1976, the Atomic Energy Commission of Japan decided its policy regarding radioactive wastes. It is stated that the sea disposal of low-level solid wastes as test will be made from about 1978, and after the confirmation of the safety, full-scale sea disposal will then follow. In this field, studies have long been made in Japan and international organizations. Based on these results, the present report describes on the following matters: the amount of radioactive wastes and the activities for disposal, the safety of disposal packages, the state of prospective sites for sea disposal, the models of the sea, the estimation of radionuclide concentrations in the ocean, and the exposure doses of general people.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 34615, 35938, 35941, 36096, 36124

34660 (BNWL—2100(Pt.5), pp 1-27) **Environmental control technology.** Jun 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 5. Control technology, overview, safety, and policy analysis.

The objective of the overall Environmental Control Technology Program is to assure that the environmental control capability for each ERDA energy technology is complete, practical, cost effective, and available in a timely manner as the energy source is developed. Program activities are oriented to identifying control technology status and needs for emerging energy systems, then developing methods and equipment for meeting these needs. Progress is reported on studies in support of both nonnuclear and nuclear technologies, with programs in oil shale, coal, energy materials transport, and nuclear fuel cycle analysis. Results are reported from studies on the environmental control technology treatment of oil shale; the assessment of environmental control technologies for commercial coal gasification; transportation safety studies; transportation problems for 1976 to 2000; a safety and economic study of special trains; development of high-level waste shipping cask models; analysis of nuclear fuel cycles; toxic materials in the nuclear fuel cycle; and decontamination and decommissioning of retired contaminated ERDA facilities at Hanford.

34661 (DOE/EDP—0022) **Environmental Development Plan (EDP): advanced isotope separation.** (Department of Energy, Washington, D.C. (USA)). Mar 1978. 89p. Dep. NTIS, PC A05/MF A01.

This Environmental Development Plan (EDP) identifies and examines the environmental, safety, health, and socioeconomic (ES and H) issues and corresponding requirements associated with the

ERDA research, development, and demonstration of the Advanced Isotope Separation (AIS) program. This EDP has been limited to the consideration of (1) overall AIS processes from feed material to product recovery, (2) laser processes (molecular and atomic vapor), (3) the plasma process, and (4) the necessary research and development activities. The key issues and requirements identified in this EDP encompass items specific to the AIS technology and items which are generic to the nuclear fuel cycle (including AIS) or multiple components of the fuel cycle. The key specific issues and requirements addressed are (1) the proliferation of this sensitive technology for the production of weapons grade material and (2) the potential occupational health effects from lasers or process chemicals and exposure to magnetic fields and electromagnetic fields. The key generic issues (which are also AIS process related are (1) the needs for the development of "as low as practicable" (ALAP) emission capabilities for effluents and (2) the identification of the radioactive contaminants in the AIS feed material.The key environmental planning elements for implementing the identified requirements are (1) scheduling the needs against the three critical technology development milestones: process selection (1981), operation of an engineering demonstration facility (EDF) (1984), and operation of a uranium tails stripper module (1990); and (2) identification of NEPA requirements and schedules, one for the process selection and construction of the EDF and one for the decision to construct and operate the stripper module.

34662 Environmental tritium transport from atmospheric release of molecular tritium. Murphy, C.E. Jr.; Watts, J.R.; Corey, J.C. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). *Health Phys.;* **33**: No. 4, 325-331(Oct 1977).

Some samples of soils, water, air, and vegetation collected along paths of two tritium releases from a tritium production facility at the Savannah River Plant, Aiken, South Carolina, showed measurable elevation in the levels of tritiated water. The highest concentrations of tritiated water were found in the soil, where molecular tritium had been converted to tritiated water. Patterns of tritiated water movement, after the initial exposure period, agreed with the other investigator's observations of tritiated water transport in terrestrial ecosystems. Dispersion and uptake were measured for puffs released under different meteorological conditions.

34663 Studies of the impact of nuclear facilities on the environment. Bovard, P. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Service d'Etudes et de Recherches sur l'Environnement); Grauby, A. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France). Service d'Etudes et Recherches sur l'Environnement). *Bull. Inf. Sci. Tech. (Paris);* No. 222, 7-9(1977). (In French).

The growth of the nuclear industry and current environmental policy make it necessary to carry out prospective and forecasting investigations of the impact of nuclear facilities. The method used at the CEA for this type of research, which benefits from the experience of some 50 investigations of this type already accomplished, both in France and abroad, is discussed.

34664 Environmental problems posed by wastes from the uranium milling industry. Bonhote, P.A. (International Atomic Energy Agency, Vienna (Austria)). pp 119-123 of Uranium ore processing. Proceedings of an advisory group meeting organized by the IAEA and held in Washington, D.C., 24-26 November 1975. Vienna; IAEA (1976).

From Meeting of the advisory group on uranium ore processing; Washington, DC, USA (24 Nov 1975).

See CONF-751192—.

The processing of uranium ores has many effects on the environment. These effects can be caused by outside influences as well as by the actual milling operations. The major impacts associated with milling are connected with the waste product produced from uranium extraction. Solid, liquid and gaseous wastes arise during processing. The environmental problems posed by wastes from uranium milling are receiving attention by the industry and by national authorities. Air pollution from mills is not a serious problem, water pollution is potentially a greater problem; but methods are available to help us overcome this problem. The problems posed by the disposal of solid tailings have not been completely resolved. Some of these problems are discussed in the paper.

HEALTH AND SAFETY

REFER ALSO TO CITATION(S) 34573, 34661, 35905

34665 (DP-MS—77-92) Methods and calculations for regional, continental, and global dose assessments from a hypothetical fuel reprocessing facility. Schubert, J.F.; Kern, C.D.; Cooper, R.E.; Watts, J.R. (Savannah River Ecology Lab., Aiken, S.C. (USA)). 19 Mar 1978. Contract EY-76-C-09-0001. 24p. (CONF-780304—2). NTIS, PC A02/MF A01.

From ANS - The Back End of the LWR Fuel Cycle; Savannah, GA, USA (19 Mar 1978).

The Savannah River Laboratory (SRL) is coordinating an interlaboratory effort to provide, test, and use state-of-the-art methods for calculating the environmental impact to an offsite population from the normal releases of radionuclides during the routine operation of a fuel-reprocessing plant. Results of this effort are the estimated doses to regional, continental, and global populations. Estimates are based upon operation of a hypothetical reprocessing plant at a site in the southeastern United States. The hypothetical plant will reprocess fuel used at a burn rate of 30 megawatts/metric ton and a burnup of 33,000 megawatt days/metric ton. All fuel will have been cooled for at least 365 days. The plant will have a 10 metric ton/day capacity and an assumed 3000 metric ton/year (82 percent online plant operation) output. Lifetime of the plant is assumed to be 40 years.

34666 Qualitative and quantitative analysis of plutonium in solid waste drums. Anno, J.; Escarieux, E. (CEA Centre d'Etudes de Bruyeres-le-Chatel, 92 - Montrouge (France)). pp 159-162 of Proceedings of the 4. International congress of the International Radiation Protection Association. Vol. 1. Fontenay-aux-Roses, France; Association Internationale de Protection contre les Rayonnements (1977). (In French)

From 4. congress of the International Radiation Protection Agency; Paris, France (24 Apr 1977).

See CONF-770409— (Available M. Gilbert Bresson, General Secretary IRPA, B.P. no. 33, 92260 Fontenary-aux-Roses, France).

An assessment of the results given by a study carried out for the development of qualitative and quantitative analysis, by γ spectrometry, of plutonium in solid waste drums is presented. After a discussion of the standards and their incidence on the quantities of plutonium to be measured (application at industrial Pu: 20% of Pu^{240}) the equipment used is described. Measurement station provided with a mechanical system consisting of: a rail and a pulley block to bring the drums; a pit and a hydraulic jack with a rotating platform. The detection instrumentation consisting of: a high volume coaxial Ge(Li) detector with a γ ray resolution of 2 keV; an associated electronic; a processing of data by a 'Plurimat 20' minicomputer. Principles of the identification and measurements are specified and supported by experimental results. They are the following: determination of the quality of Pu by measuring the ratio between the γ ray intensities of the ^{239}Pu 129 keV and of the ^{241}Pu 148 keV; measurement of the ^{239}Pu mass by estimating the γ ray counting rate of the 375 keV from the calibrating curves given by plutonium samples varying from 32 mg to 80 g; correction of the results versus the source position in the drum and versus the filling in plastic materials in this drum. The experimental results obtained from over 40 solid waste drums are presented along with the error estimates.

34667 Rock sealant restricts falling barometer effect. Bates, R.C. (US Bur of Mines, Spokane, Wash). *Min. Eng. (N.Y.);* **29**: No. 12, 38-39(Dec 1977).

This rebuttal to a previous article provides new insight into the use of sprayed sealants in uranium mines. The author rejects the idea that the value of rock sealant on radon control is destroyed by changes in barometric pressure, showing that this is not necessarily true. The analyses described demonstrate that radon contamination resulting from changing barometric pressures is reduced by a rock coating. The overall use of coatings depends on their costs and effectiveness as compared with other radon control measures. 6 refs.

REGULATIONS

ACCOUNTABILITY AND SAFEGUARDS

34668 (NUREG—0320) Interior intrusion alarm systems. Prell, J.A. (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Standards Development). Jan 1978. 44p. NTIS $4.50.

In meeting the requirements for the safeguarding of special nuclear material and the physical protection of licensed facilities, the licensee is required to design a physical security system that will meet minimum performance requirements. An integral part of any physical security system is the interior intrusion alarm system. The purpose of this report is to provide the potential user of an interior intrusion alarm system with information on the various types, components, and performance capabilities available so that he can design and install the optimum alarm system for his particular environment. In addition, maintenance and testing procedures are discussed and recommended which, if followed, will help the user obtain the optimum results from his system.

34669 (SAND—78-6006) Application of neutron monitors in fuel fabrication and reprocessing installations. Arnal, T.; Dumesnil, P.; Edeline, J.C.; Ganivet, M. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France); CEA Centre

d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). Mar 1978. Translation by P. Newman of IAEA-CN—36/253, 1977. (CONF-770505—304(Trans.)). 27p. Dep. NTIS, PC A03/MF A01.

From International conference on nuclear power and its fuel cycles; Salzburg, Austria (2 May 1977).

Plutonium is detected and measured by means of its neutron emission: spontaneous fission of like isotopes and (α, n) reactions. Neutron emission intensity thus depends on the isotopic composition and the chemical nature of the Pu source. Waste containers are monitored by counting spontaneous fissions alone, which is made possible by the nonpoisson timing of the corresponding neutron events. The equipment comprises 24 ^{3}He counters and can detect 10 mg(^{240}Pu) in one minute in a 100 litre container. The door is monitored to detect small masses of plutonium in order to prevent the removal of this element. The door monitor comprises a variable number of ^{3}He counters placed around the doorway. An alarm rings if the number of counts per second exceeds a predetermined threshold value. A motion detector consisting of a Doppler radar limits the frequency of false alarms due to statistical fluctuations in the background. Sensitivity is on the order of several grams of Pu.

34670 Material accountability: theory, verification, and applications. Avenhaus, R. New York; John Wiley and Sons (1977). 198p.

Accountability for all goods used in an industrialized society is addressed in this book. A thorough review of the analytical tools that have been developed to deal with keeping track of rare or dangerous materials is presented. The application of these same tools and techniques to the monitoring of the flow of pollutants, i.e., SO_2; potentially dangerous materials, i.e., CO_2; or rare materials, such as metals in a mint. The material in the book is divided into 8 chapters entitled: Introduction, Data Verification, Systems Aspects, International Nuclear Materials Safeguards, Material Accountability in Technology and Economics, Environmental Accountability, and Arms Control. (BLM)

ADMINISTRATIVE AND REGULATORY

34671 (GJO—108(77), pp 227-232) **Overview of NRC mill licensing activities.** Martin, J.B. (Nuclear Regulatory Commission, Washington, DC). 1977.

From Uranium industry seminar; Grand Junction, CO, USA (26 Oct 1977).

In Uranium industry seminar.

Actions during the year by NRC to alleviate problems associated with tailings management are reviewed. Information is included on licensing activities and review times, regulatory guides, generic environmental impact statements, and fuel cycle standards. (JRD)

FUSION FUELS

PROCESSING

REFER ALSO TO CITATION(S) 36560

FABRICATION AND TESTING

34672 Method for mounting laser fusion targets for irradiation. Fries, R.J.; Farnum, E.H.; McCall, G.H. (to Energy Research and Development Administration). US Patent 4,038,125. 26 Jul 1977. Filed date 18 Jun 1975. 6p.

PAT-APPL-588,119.

Methods for preparing laser fusion targets of the ball-and-disk type are disclosed. Such targets are suitable for irradiation with one or two laser beams to produce the requisite uniform compression of the fuel material.

34673 Method for foam encapsulating laser targets. Hendricks, C.D. (to Energy Research and Development Administration). US Patent 4,034,032. 5 Jul 1977. Filed date 2 Sep 1975. 10p.

PAT-APPL-609,640.

Foam encapsulateed laser fusion targets are made by positioning a fusion fuel-filled sphere within a mold cavity of suitable configuration and dimensions, and then filling the cavity with a material capable of producing a low density, microcellular foam, such as cellulose acetate dissolved in an acetone-based solvent. The mold assembly is dipped into an ice water bath to gel the material and thereafter soaked in the water bath to leach out undesired components, after which the gel is frozen, then freeze-dried wherein water and solvents sublime and the gel structure solidifies into a low-density microcellular foam, thereafter the resulting foam encapsulated target is removed from the mold cavity. The fuel-filled sphere is surrounded by foam having a thickness of about 10 to 100 μm, a cell size of less than 2 μm, and density of 0.065 to 0.6 x 10^3 kg/m^3. Various configured foam-encapsulated targets capable of being made by this encapsulation method are illustrated.

34674 Method of making foam-encapsulated laser targets. Rinde, J.A.; Fulton, F.J. (to Energy Research and Development Administration). US Patent 4,021,280. 3 May 1977. Filed date 2 Sep 1975. 10p.

PAT-APPL-609,642.

Foam-encapsulated laser fusion targets are fabricated by suspending fusion fuel filled shells in a solution of cellulose acetate, extruding the suspension through a small orifice into a bath of ice water, soaking the thus formed shell containing cellulose acetate gel in the water to extract impurities, freezing the gel, and thereafter freeze-drying wherein water and solvents sublime and the gel structure solidifies into a low-density microcellular foam containing one or more encapsulated fuel-filled shells. The thus formed material is thereafter cut and mounted on a support to provide laser fusion targets containing a fuel-filled shell surrounded by foam having a thickness of 10 to 60 μm, a cell size of less than 2 μm, and density of 0.08 to 0.6 x 10^3 kg/m^3. Various configured foam-encapsulated targets capable of being made by the encapsulation method are illustrated.

34675 Method for producing laser targets. Jarboe, T.R.; Baker, W.R. (to Energy Research and Development Administration). US Patent 4,017,578. 12 Apr 1977. Filed date 12 Jun 1975. 8p.

PAT-APPL-586,459.

An apparatus and method for producing deuterium targets or pellets of 25μ to 75μ diameter. The pellets are sliced from a continuously spun solid deuterium thread at a rate of up to 10 pellets/second. The pellets after being sliced from the continuous thread of deuterium ar collimated and directed to a point of use, such as a laser activated combustion or explosion chamber wherein the pellets are imploded by laser energy or laser produced target plasmas for neutral beam injection.

PROPERTIES

REFER ALSO TO CITATION(S) 35753

34676 Equation of state of fluid n-D_2 from P-V-T and ultrasonic velocity measurements to 20 kbar. Mills, R.L.; Liebenberg, D.H.; Bronson, J.C. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Chem. Phys.;* **68**: No. 6, 2663-2668(15 Mar 1978).

The molar volume V and ultrasonic velocity u of fluid n-D_2 were measured simultaneously in a piston-cylinder apparatus over the range $75<T<300$ K and $2<P<20$ kbar. The data were fitted to an equation of state of the Benedict type which reproduced the 1404 experimental data sets of V and u within an average deviation of 0.4%. Values of the thermodynamic properties of n-D_2 were calculated and compared with those from a parallel study of n-H_2 in an attempt to treat isotopic effects.

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

PHYSICAL ISOTOPE SEPARATION

REFER ALSO TO CITATION(S) 35783, 35792

34677 (LA-UR—78-523) **TRISTAN I: techniques, capabilities, and accomplishments.** Talbert, W.L. Jr. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 24p. (CONF-771078—3). Dep. NTIS, PC A02/MF A01.

From Workshop on ISOL systems; Upton, NY, USA (31 Oct 1977).

Following a brief description of the TRISTAN facility, the techniques developed for on-line nuclear spectroscopy of short-lived fission products, the studies possible, and the activities studied are presented. All journal publications relating to the development of the facility and the studies carried out using it are referenced, and co-workers identified.

34678 (LBL—6016, pp 413-432) **Laser concepts.** 1976.

In Materials and Molecular Research Division annual report, 1976.

The purpose of the program is two-fold and includes: (1) use of the molecular beams method to investigate basic physical and chemical processes which play important roles in various established isotope separation processes; and (2) by taking advantage of both the molecular beams method and laser technology, new concepts and new methods for efficient separation of isotopes might be developed. The three methods investigated using molecular beam laser isotope separation schemes include: (1) selective decomposition of van der

Waal's molecule-recoil separation through vibrational relaxation; (2) selective condensation through modification of sticking coefficients; and (3) molecular beam studies of multiphoton dissociations.

OTHER INDUSTRIAL USES

REFER ALSO TO CITATION(S) 34681

ISOTOPIC POWER SUPPLIES

34679 (GA-A—14807) **Quality assurance program document for 75 mW radioisotope thermoelectric generator program.** Gregory, B.M. (General Atomic Co., San Diego, Calif. (USA)). Sep 1977. Contract EY-76-C-03-0167-060. 16p. Dep. NTIS, PC A02/MF A01.

The General Atomic Company Quality Assurance Document (QAPD) for the 75 mW Radioisotope Thermoelectric Generator (RTG) Program serves the following purposes: (1) identifies the QA Manual and special requirements for the Quality Assurance Program for the design, fabrication assembly, testing, and delivery of the 5 75-mW RTG's and the 2 75-mW Electrical Thermoelectric Generators (ETG) Test Units in accordance with the contractural requirements; (2) describes the operating agreements and relationships between GA and other participants on quality assurance matters on the program; (3) identifies the equipment and activities subject to the Quality Assurance Program and defines GA's scope of supply and documentation requirements for retention and delivery to the Customer; (4) identifies the personnel in key positions, assigned the responsibility for defining, approving, and implementing the QA program; (5) provides a document in which special quality assurance requirements or procedures may be described or identified for implementation during the program; and provides a controlled and identified document to which the customer may refer in signifying their approval of the quality assurance program that will be implemented by GA for the items within the scope of supply.

34680 (PNL—1845-37) **Quarterly report on the strontium heat source development program and the terrestrial radioisotope applications program, Advanced Systems and Materials Production Division for October—December 1977.** Fullam, H.T. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jan 1978. Contract EY-76-C-06-1830. 39p. Dep. NTIS, PC A03/MF A01.

A separate abstract was prepared for each of the two sections of the report. (TFD)

34681 (PNL—1845-37, pp 27-30) **Terrestrial radioisotope applications program.** Van Tuyl, H.H.; Sande, W.E. Jan 1978.

In Quarterly report on the strontium heat source development program and the terrestrial radioisotope applications program, Advanced Systems and Materials Production Division for October—December 1977.

The major objective of this program is to identify potential beneficial uses of nuclear reactor by-product through three principal tasks: (1) evaluation of long-term availability and cost of useful isotopes from commercial suppliers or military wastes; (2) evaluation of beneficial applications of isotopes; and (3) identification and evaluation of the actions required to optimize the $^{90}SrF_2$ and $^{137}CsCl$ products from the Hanford Waste Encapsulation and Storage Facility (WESF) for beneficial uses.

DESIGN AND FABRICATION

34682 (PNL—1845-37, pp 1-25) **Strontium heat source development program.** Van Tuyl, H.H.; Fullam, H.T.; Atteridge, D.G.; Simonen, F.A. Jan 1978.

In Quarterly report on the strontium heat source development program and the terrestrial radioisotope applications program, Advanced Systems and Materials Production Division for October—December 1977.

At Hanford, strontium is separated from the high-level waste, converted to the fluoride, and doubly encapsulated in small, high-integrity containers for subsequent long-term storage. The fluoride conversion, encapsulation and storage take place in the Waste Encapsulation and Storage Facilities (WESF). The encapsulated strontium fluoride represents an economical source of ^{90}Sr if the WESF capsule can be licensed for heat source applications under anticipated use conditions. The objectives of this program are to obtain the data needed to license $^{90}SrF_2$ heat sources and specifically the WESF $^{90}SrF_2$ capsules. Topics discussed include chemical and physical properties of $^{90}SrF_2$, $^{90}SrF_2$ compatibility studies, and capsule qualification and licensing.

34683 **Thermionic energy converters.** Monroe, J.E. Jr. (to Energy Research and Development Administration). US Patent 4,040,903. 9 Aug 1977. Filed date 3 Sep 1974. 10p.

A thermionic device is described for converting nuclear energy into electrical energy comprising a tubular anode spaced from and surrounding a cylindrical cathode, the cathode having an outer emitting surface of ruthenium, and nuclear fuel on the inner cylindrical surface. The nuclear fuel is a ceramic composition of fissionable material in a metal matrix. An axial void is provided to collect and contain fission product gases.

34684 **Deep diode atomic battery.** Anthony, T.R.; Cline, H.E. (to General Electric Co.). US Patent 4,024,420. 17 May 1977. Filed date 27 Jun 1975. 20p.

A deep diode atomic battery is made from a bulk semiconductor crystal containing three-dimensional arrays of columnar and lamellar P-N junctions. The battery is powered by gamma rays and x-ray emission from a radioactive source embedded in the interior of the semiconductor crystal.

USES

34685 (PNL—2476) **Economic feasibility of strontium-90 fueled heaters for use in cold regions.** Sande, W.E.; Aaberg, R.L. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Feb 1978. Contract EY-76-C-06-1830. 54p. Dep. NTIS, PC A04/MF A01.

This study was conducted to conceptually design and obtain cost estimates for various radioisotope fueled heating systems for use in potential cold regions applications, and to determine the economic feasibility of radioisotope fueled heaters by comparing them to fuel oil systems. The applications have been identified and grouped, according to thermal output: (1) 1 kWt septic tank heaters, well-head heaters, heaters to assist operation of sewage lagoons, and (2) 7 or 12 kWt potable water system heaters. Potentially economic locations for these heaters are in remote Alaskan communities of 50 to 200 residents, where fuel oil prices and reliability requirements are high. Two basic conceptual heat designs were considered: a heat source and radiation shielding with no external heat transfer equipment, and a heat source and radiation shielding with external heat transfer equipment. Costs for both conceptual designs were estimated for heater sizes of 1 kWt, 7 kWt, and 12 kWt. The major costs were for the heat source and equipment. Radioisotope heaters were found to be much more expensive than fuel oil systems. The radioisotope fuel costs contribute 50 percent or more to the overall cost. Thus, an effective method to make a substantial reduction in radioisotope system cost would be to lower the Sr price from 10 cents/curie. It was concluded that radioisotope heaters will not be economically competitive with fuel oil systems unless one or more of the following situations occur: the price of strontium-90 is reduced below 10 cents/curie; fuel oil prices increase significantly; or for a particular application, the reliability or adaptability of a fuel oil system is unacceptable and a radioisotope system is satisfactory.

HYDROGEN

PRODUCTION

REFER ALSO TO CITATION(S) 34731

34686 **Process for production of carbon monoxide and hydrogen.** Wainer, E. (to Horizons Research Inc.). US Patent 4,074,980. 21 Feb 1978. Filed date 2 Jul 1976. 14p.

Carbon monoxide and hydrogen are produced by spraying a mixture of molten sodium and/or potassium from one nozzle into a chamber maintained at a temperature of 650 to 850°C along with one or more separated sprays containing a slurry of carbon, water and carbon dioxide so that the various sprays contact each other in said hot chamber so constructed so that the reactants are forced into a suitably constructed reactor containing iron and/or its oxide in a semifluid bed powdered condition. Preferably, the reactor contains mixtures of the metals and/or oxides taken from the class of iron, cobalt, nickel and manganese. In a cyclic reaction, the metallic sodium is reconstituted along with continued production of carbon monoxide and hydrogen, the iron type component remaining in the reactor which as a consequence of the reagents and conditions is cyclically oxidized to oxides of iron type elements and reduced to finely divided iron and/or mixtures of iron, cobalt, nickel and manganese. The sodium vapor is condensed rapidly and the carbon monoxide and hydrogen passes to a gas holder. The incoming reagents are fed to the reactor at a temperature of 350 to 380°C, which temperature is maintained by appropriate heat exchange obtained from the heat contained in the reaction products. The reconstituted alkali metal is recycled throught the reactor along with the preheated and added carbon, carbon dioxide and water. Siliceous ash is extracted from the reactor periodically as a finely divided non-fused powder, principally in the form of calcium metasilicate produced as a consequence of adding finely divided limestone to the reaction mixture.

34687 Magnesium composites and mixtures for hydrogen generation and method for manufacture thereof. Suzuki, M. US Patent 4,072,514. 7 Feb 1978. Priority date 20 Apr 1971, Japan. 6p.

Magnesium composites and mixtures prepared in accordance with the method herein disclosed readily induce vigorous generation of hydrogen upon introduction into water. Magnesium composites having iron, zinc, chromium, aluminum and manganese attached in a finely divided form to the surface of magnesium articles are produced by causing said finely divided metals to adhere to the surface of magnesium articles by virtue of application of mechanical pressure. Magnesium mixtures having the said finely divided metals dispersed in magnesium articles are produced by melting magnesium, adding the said metals in a finely divided form to the molten magnesium and allowing the resultant mixtures to cool.

ELECTROLYSIS

REFER ALSO TO CITATION(S) 34910

34688 (BNL—23931) **Hydrogen-technology equipment test program at BNL.** Strickland, G.; Beaufrere, A.H.; Rosso, M.J. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 11p. (CONF-771131—5). NTIS, MF A01.

From DOE annual chemical energy storage and hydrogen energy system contracts review; Baltimore, MD, USA (16 Nov 1977).

In furthering the development of hydrogen energy technology it is essential to test both major and supporting components on a practical scale. The Hydrogen-Technology Advanced-Component Test System (HYTACTS) is being constructed to fulfill this need. Components for production of hydrogen by electrolysis, storage of hydrogen as a metal hydride, and use in several types of energy conversion devices will be tested and evaluated. The first application to be evaluated uses hydrogen as an energy carrier in an electric-energy storage system. Off-peak or spinning-reserve power is used to electrolyze hydrochloric acid; the hydrogen and chlorine are stored for recombination in the same cell when the demand for power exceeds the system capacity. Hydrogen stored in containers of hydride will also be tested for use as an automotive fuel. The program phases are described along with some details on the equipment to be tested in the hydrogen storage section of the system now being constructed.

34689 Review of the potential use of nuclear reactors for hydrogen production. Worley, N.G. (Babcock and Wilcox (Ops) Ltd, London, Engl). *Gas Eng. Manage.;* **17**: No. 10, 371-383(Oct 1977).

Except for marine propulsion, nuclear power, up to now, has only been used for electricity generation. The paper reviews the types of nuclear reactors available, the characteristics of the electricity industry and the way that nuclear power could supplement the supplies of gas when these become less abundant early in the twenty-first century. The route using high temperature reactors appears basically less attractive than electrolysis particularly when the increasing need for nuclear reactors which can "breed" new fuel is taken into consideration. Some general comments on electrolysis plant are made together with some indications of the type of problem involved in their integration into the electricity/gas structure. 8 refs.

THERMOCHEMICAL PROCESSES

REFER ALSO TO CITATION(S) 34689

34690 Process for producing hydrogen and oxygen from water. Pangborn, J.B.; Sharer, J.C.; Elkins, R.H. (to American Gas Association). US Patent 4,075,313. 21 Feb 1978. Filed date 18 Mar 1976. 14p.

A process is claimed for the production of hydrogen and oxygen from water comprising the steps of forming ferric chloride from ferriferrous oxide by reaction with a chloride ion yielding substance, thermally reducing the ferric chloride to produce ferrous chloride, reducing the ferrous chloride to metallic iron, then oxidizing the metallic iron with water so as to produce hydrogen. The metallic iron may be formed by reducing the ferrous compound with hydrogen. Two specific reactant regenerative closed cycle systems are disclosed utilizing the process of this invention for the production of hydrogen and oxygen.

STEAM REFORMER PROCESSES

REFER ALSO TO CITATION(S) 34689, 35310

PARTIAL OXIDATION PROCESSES

34691 Method and apparatus for generating reformed gas containing hydrogen and carbon monoxide from hydrocarbon fuel. Kosaka, K.; Ueno, Z. (to Nissan Motor Co., Ltd.). US Patent 4,059,076. 22 Nov 1977. Priority date 21 Apr 1975, Japan. 6p.

A hydrocarbon fuel is subjected to combustion in an internal combustion engine by the use of excess air, and the exhaust gas is utilized as heat and oxygen sources for partial oxidation of the hydrocarbon fuel in a separate reformer. A resulting mixture of the reformed gas and the exhaust gas is subjected to heat exchange with air to be drawn into the engine and/or the fuel to be supplied to the reformer and thereafter is supplied to a larger internal combustion engine.

STORAGE

CHEMISORPTION

REFER ALSO TO CITATION(S) 34688, 35653

34692 Behavior of iron titanium hydride test beds: long-term effects, rate studies and modeling. Strickland, G.; Milau, J.; Yu, W.S. (Brookhaven Natl Lab, Upton, NY). *Int. J. Hydrogen Energy;* **2**: No. 3, 309-327(1977).

Several types of studies were made with test beds of iron titanium hydride (FeTiH$sub x$) in order to determine their long-term and thermal behavior. This material provides a way of storing hydrogen in relatively dense form at ordinary temperatures and moderate pressures. Its use offers electrical utilities a way of storing low-cost off-peak power, to meet costly peak-shaving needs, in combination with an electrolyzer and a fuel cell stack. The data obtained is part of that needed for the design of plant-scale hydride reservoirs. Accelerated cyclic tests were made with 1-in. diam test beds to determine changes in their long-term behavior, the main result being extensive particle attrition. 4 refs.

34693 Use of metal hydrides for hydrogen storage in automotive and stationary applications. Beccu, K.D. (Battelle Memorial Inst., Geneva). pp 8p, Paper 6B1 of Hydrogen in metals. Vol. 10. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P10.

Metal hydrides offer for certain sectors of potential hydrogen application, such as motive power and off-peak energy storage, a solution to the key problem of hydrogen storage. Significant hydride storage characteristics are discussed in view of the application's requirements.

34694 Absorption of hydrogen by metallic compounds and conversion of heat engines for operation on hydrogen. Barmin, V.P.; Podgornii, A.N.; Savitskii, Y.M.; Varshavskii, I.L.; Terekhova, V.F.; Markova, I.A. pp 7p, Paper 6A7 of Hydrogen in metals. Volume 3. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P3.

A study has been made into the kinetics of the process of absorption of hydrogen by compounds $LaNi_5$ and TiFe and its liberation from the resulting hydrides. The possibility of using these compounds as hydrogen accumulators in heat engines operating on hydrogen has been examined. The advantages of employing hydrides for this purpose are shown.

INDUSTRIAL AND COMMERCIAL USE

REFER ALSO TO CITATION(S) 34693, 34694

34695 Hydrogen as an automobile fuel. Furuhama, S. (Musashi Inst of Technol, Jpn). *Nenryo Kyokai-shi;* **56**: No. 9, 721-731(1977). (In Japanese).

Potential use of liquid hydrogen as an automotive fuel is critically examined. To achieve good thermal efficiency, low nitric oxide emissions and to avoid abnormal combustion, the maximum output power of the hydrogen fueled engine should be increased to the greatest possible degree, and the engine operated with lean mixture. The characteristics of hydrogen gas, liquid hydrogen and metal hydride for automobile fuels are described in detail, and the methods of controlling backfiring are discussed. 10 refs.

PROPERTIES

REFER ALSO TO CITATION(S) 35667, 35668

34696 Catalytic combustion of premixed hydrogen-air. Mori, Y.; Miyauchi, T.; Hirano, M. (Tokyo Inst of Technol, Jpn). *Combust. Flame;* **30**: No. 2, 193-205(1977).

An experiment was made as an example of low temperature combustions which would produce no nitrogen oxide in hydrogen-air premixed gas. Measurements of the temperature and concentration distributions in the boundary layer on a catalytic platinum plate were taken in the range of 2-p mol N of the free stream hydrogen concentration and 2-4 m/s of the free stream velocity. From detailed observation of the surface, it became clear that catalytically active regions are not uniformly distributed. The comparison of the results of theoretical prediction and the experimental result, showed that the average hydrogen concentration, over some extent of the surface, is not zero and that the concentration boundary layer only becomes thin. 10 refs.

34697 Thermal blocking and flow structure in a channel with a step during combustion of hydrogen. Baev, V.K.; Klimchik, G.V.; Konstantinovskii, V.A., Solovova, Y.A.; Tret'yarov, P.K. *Aerofiz. Issled.;* No. 6, 65-67(1976). (In Russian).

Results are presented from an experimental study of thermal blocking in a channel with a step during combustion of hydrogen. The experiments were performed with a Mach number M = 2.0. In the process of measurement, the change in static pressure along the length of the channel was recorded, the flame was photographed directly and the flow was visualized by means of a shadow device. Based on the results of gas analysis and measurements of the total pressure in the exit cross section of the channel, the distribution of values of Mach number, velocities and temperatures through the cross section of the channel at near critical modes are determined. In spite of the significant nonuniformity of parameters over the cross section, thermal blocking is evaluated on the basis of a one-dimensional model, using the method of averaging suggested by Krokko. A critical flow mode is calculated on the basis of the model. Comparison of the results of measurements and calculated quantities proves the applicability of the model used. Based on the results of cold blowing, the heat transfer to the walls is estimated. A study is made of the flow structure in the channel as thee flow rate of hydrogen is changed. References 8.

34698 Change in pressure beyond a step in a flat channel during combustion of hydrogen. Baev, V.K.; Klimchik, G.V.; Konstantinovskii, V.A.; Solovova, Y.A.; Tret'yakov, P.K. *Aerofiz. Issled.;* No. 6, 67-69(1976). (In Russian).

Results are presented from a study of the process of combustion of hydrogen in a wake beyond a step in a flat channel. In addition to the measurements of pressure on the lower wall of the channel, the flame was photographed directly and the flow was visualized by a shadow instrument. Measurements were performed at Mach number M = 2.0 and 2.5. It was noted that as the hydrogen consumption was increased, a "secondary" increase in pressure on the wall occurred, accompanied by the formation of a zone of further combustion, in which the static pressure was higher. The measurements of total pressure at the exit from the channel showed that at the moment of "secondary" increase in pressure, the velocity of the stream at the lower wall becomes subsonic and the flow in the channel from that moment onward is a two-layer flow. It is noted that the primary factor influencing the bottom pressure is the relative heat transfer upon combustion of the hydrogen.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 34696

OTHER SYNTHETIC AND NATURAL FUELS

HYDROCARBON FUELS

REFER ALSO TO CITATION(S) 34911, 35391

PROPERTIES

REFER ALSO TO CITATION(S) 34706, 35755, 35787, 35788

34699 (FE—2489-16) Development of combustion data to utilize low-Btu gases as industrial process fuels. Project 8985 annual report, October 1, 1976—September 30, 1977. Waibel, R.T. (Institute of Gas Technology, Chicago, Ill. (USA)). Jan 1978. Contract EX-76-C-01-2489. 40p. Dep. NTIS, PC A03/MF A01.

The objective of this project is to provide the combustion data needed to retrofit existing industrial burners to low- and medium-Btu fuel gases. The IGT pilot-scale furnace was modified to allow the insertion of cooling tubes to provide an adjustable furnace load. This allows the furnace to simulate a variety of industrial processes. The Surface Combustion Division of Midland-Ross Corp. constructed a special gas-generating system for producing the necessary low- and medium-Btu gases. A Bloom baffle burner, representative of the forward flow type of burner, was installed as the first type of burner to be tested. The cooling tubes were adjusted to simulate the load in the preheat zone of a five-zone steel slab reheat furnace, and natural gas baseline data were collected with an input of 5.25 million Btu/hr. The combustion trials included measurements of the thermal efficiency, heat absorption profile, flame shape, flame temperatures, resonance noise level, and flow direction profiles. The thermal efficiencies were 35% for natural gas, 26% for KTO, 23% for WGA, and 22% for WA. The efficiency is the amount of heat absorbed by the cooling tube load relative to the fuel enthalpy input of 5.25 million Btu/hr. The peak flame temperatures were 1672°C (3042°F) for natural gas, 1650°C (3002°F) for KTO, 1351°C (2464°F) for WGA, and 1396°C (2545°F) for WA. All of the substitute fuels had longer flames than natural gas. Because the Winkler air heat absorption profile and furnace efficiency were distinctly different from the natural gas baseline and due to the flame stability problem, combustion trials were begun with a larger fuel nozzle and modified baffle.

34700 Heat transfer during the boiling of ethane and ethylene. Kravchenko, V.A.; Tolubinskaya, L.F. *Int. Chem. Eng.;* **18**: No. 1, 78-81(Jan 1978).

Translated from Teplofiz. Teplotekh.; 18: No. 31, 61-64(1976).

An experimental study of the heat transfer coefficients during the boiling of ethane and ethylene in a large volume at the surface of a stainless steel tube was made as functions of the heat flux density and the results correlated. The following equation is recommended: (α/lambda) root [σ/g(rho' - rho'')] = [illegible] [q/r rho''W'']/sup 0.7./[ν/a]/sup -0.2/.

34701 Mechanism of thermal oxidation of methane in reactors conditioned with boric acid and potassium bromide. Kegeyan, E.M.; Vardanyan, I.A.; Nalbandyan, A.B. (Inst. of Chemical Physics, Erevan). *Kinet. Catal. (USSR) (Engl. Transl.);* **18**: No. 4, 685-690(Jan 1978).

Translated from Kinet. Katal.; 18: No. 4, 823-829(1977).

A mechanism for the thermal oxidation of methane is proposed which explains the experimental data obtained in reactors conditioned with boric acid and potassium bromide. According to this mechanism, methyl hydroperoxide is the product responsible for degenerate chain branching at 440—513°C.

34702 Composite determination of thermophysical properties of hydrocarbon fluids. Glazunov, V.I.; Mazitov, I.M. *Ind. Lab. (USSR) (Engl. Transl.);* **43**: No. 4, 552-554(Apr 1977).

Translated from Zavod. Lab.; 43: No. 4, 466-468(Apr 1977).

A method and apparatus are described for determining the entire set of thermophysical properties of hydrocarbon fluids in a single test, whether the tested hydrocarbons are highly volatile or highly viscous at room temperature. With the described thermoreceiver assembly thermostaticized, the temperature range of measurements can be extended to -50°C. Experimental data for several hydrocarbon fluids with the apparatus described are tabulated and compared with data reported by others. The relative error of measurements is < +- 2.0%.

PREPARATION

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 36074, 36075, 36076

34703 Bioconversion of solar energy to methane. Keenan, J.D. (Univ. of Pennsylvania, Philadelphia). *Energy (Oxford);* **2**: No. 4, 365-373(Dec 1977).

The purpose of this paper is to report the results of an investigation of the energy conversion efficiency of an aquatic based fuel-from-biomass system. The bases of the system are the biochemical conversions of solar energy to algal biomass to methane which is, in turn, used as auxiliary fuel for a fossil-fuel-fired steam-electric power plant. The alga used in the research was Anabaena flos-aque, a blue-green alga possessing many of the characteristics desired in an energy crop. The results of the research indicate that renewable methane can significantly reduce the imported fossil fuel requirement of the power station; that an overall efficiency of the conversion of solar energy to methane of one percent is attainable; and that energy inputs accounts for 12% of the methane fuel value.

34704 Mobilization and impacts of bio-gas technologies. Parikh, J.K.; Parikh, K.S. (International Inst. for Applied Systems Analysis, Laxenburg, Austria). *Energy (Oxford);* **2**: No. 4, 441-455(Dec 1977).

Energy and fertilizer requirements of many of the developing countries are largely met by locally available, non-commercial sources, such as firewood and farm wastes. Extensive use of firewood is one of the factors that can lead to deforestation. When organic farm wastes are burnt, soil nutrients are lost and this can severely affect agricultural production. The problem of efficient utilization of these locally available resources needs to be studied in a systematic manner. As an option for efficient utilization of local resources, bio-gas plants are considered, taking India as a case study. In these plants, animal dung and agricultural byproducts are utilized to obtain both methane and fertilizer through anaerobic fermentation. The economic benefits to a family using a bio-gas plant and the impact of its widespread acceptance on a national scale are evaluated. To realize the potential of bio-gas fully, village plants of about 200 m^3 capacity for approx. 100 families are needed. The introduction of such seemingly sensible new technologies has failed in the past for want of appropriate management and organizational structures and for want of social participation by persons of various income groups in the successful operation of such community plants. To remedy this, a pricing policy for purchase of farmwastes and distribution of gas and fertilizer has been suggested as an essential tool to ensure that no one is worse off by the introduction of bio-gas plants and to motivate the required participation in the scheme. The impact of full-scale adoption could mean that, by 2000 AD, almost 90% of the rural energy requirements of the domestic sector could be met. The consequent reduction in firewood consumption would help prevent deforestation. Organic manure containing two million tons of additional nitrogen would be available every year to enhance soil nutrients, hence boosting food production and helping to solve the problem of sanitation at the same time.

CHEMICAL SYNTHESIS

REFER ALSO TO CITATION(S) 34368

PREPARATION FROM WASTES OR BIOMASS

REFER ALSO TO CITATION(S) 36074, 36075, 36076

PROPERTIES

34705 Detection and role of hydroxyl and perhydroxyl radicals in the heterogeneous decomposition of hydrogen peroxide. Carlier, M.; Sahetchian, K.; Sochet, L.R. (Universite des Sciences et Techniques, Lille). *C. R. Hebd. Seances Acad. Sci., Ser. C;* **286**: No. 4, 123-126(30 Jan 1978). (In French).

The heterogeneous decomposition of hydrogen peroxide has been studied betwen 60 and 350°H_2O_2J by flowing a H_2O_2—H_2O-N_2 mixture in a tube filled with small balls coated with KCl, at different pressures (5 to 10 torr or 0.1 to 0.3 torr) and with a contact time close to 2 x 10^{-3}S. Under different conditions of H_2O_2 concentration, the OH. and HO_2. radicals have been detected by ESR by freezing them at 77 K from the gas phase. The variation of HO_2. concentration against H_2O_2 has been established. The HO_2. radicals come from a gas phase reaction between H_2O_2 and OH. radicals, which are produced by the decomposition of H_2O_2 at the walls.

PREPARATION

REFER ALSO TO CITATION(S) 34368

SOLID WASTE FUELS

REFER ALSO TO CITATION(S) 34484, 34857

GASEOUS WASTE FUELS

34706 Review of combustion problems associated with low calorific value gases. Syred, N.; Dahmen, K.R.; Styles, A.C.; Najim, S.A. (University Coll., Cardiff, Wales). *J. Inst. Fuel;* **50**: No. 405, 195-207(Dec 1977).

This paper reviews a number of recent developments in the field of burning low calorific value waste gases. It is demonstrated that gases of as low a calorific value as 1.34 MJ/m^3 (320 kcal/m^3) can be efficiently burnt in cyclone/swirl burner furnace combinations of simple construction with low pressure drop. Flame stabilization needs to occur by two mechanisms: namely aerodynamic recirculation of hot and chemically active species to one side of an annular flame front and heat re-radiation from a nearby refractory wall. Four practical combustion systems are described as follows: (a) A multi-inlet cyclone combustor which proved capable of burning gases of calorific value as low as 1.34 MJ/m^3 (320 kcal/m^3). (b) A swirl burner/furnace combination which could not burn waste gases of as quite as low a calorific value as (a) above, but was of simpler construction. (c) A small waste gas/multi-fuel swirl burner for drying and other applications. (d) A prototype cyclone combustor based on experience gained with (a) above and cyclone dust separator practice but once again a simpler construction, to illustrate more fully the effects of aerodynamic recirculation and heat re-radiation on flame stabilization. All the above systems have low pressure drop and turndown ratios of up to 5 to 6:1. 15 figs.

HYDRO ENERGY

PLANT DESIGN AND OPERATION

REFER ALSO TO CITATION(S) 35303, 35304, 35305, 35306

34707 (IDO—10073) **Idaho Falls, City hydroelectric power plant: preliminary report.** (International Engineering Co., Inc., San Francisco, Calif. (USA)). Feb 1978. Contract EG-77-A-07-1670. 170p. Dep. NTIS, MF A01.

Portions of document are illegible.

Feasibility studies for the Idaho Falls City Hydroelectric Power Plant are reported. Presented are the results of studies of four alternatives, an environmental evaluation of the site, and a recommended plan for redevelopment of the site. It is concluded that installation of one 7200-kW bulb turbine-generator is technically and economically feasible and the most attractive of the alternatives investigated. Furthermore, since the City Power Plant is part of an overall three-plant project, installing three identical units of 7200 kW, one at each site, is recommended.

34708 Design of earth- and rockfill dams for La Grande. Pare, J.J.; Larocque, G.S.; Schneeberger, C.E. (Soiete d'energie de la Baie James, Montreal). *Int. Water Power Dam Constr.;* **30**: No. 1, 38-45(Jan 1978).

The La Grande complex, currently under construction in northern Quebec, Canada, is one of the world's major hydroelectric developments. Placement of more than 200 x 10^6 yd^3 (150 x 10^6 m^3) of fill is required for the construction of about 150 earth and rockfill dams and dykes. The design of these structures was standardized to some extent by establishing a set of specific design criteria which are described. Internal zoning, external slopes, crest details, and foundation treatments are discussed.

34709 Trend to zero cavitation in hydraulic turbine operation. Pawlikewich, W. (Manitoba Hydro, Canada); Sinclair, J.P. *Int. Water Power Dam Constr.;* **30**: No. 1, 46-52(Jan 1978).

A discussion is given on the need for zero cavitation pitting damage or cavitation-free operation in fixed-blade propeller turbines in hydroelectric power plants. Historical data are presented and concepts for new projects are discussed as they apply specifically to Manitoba Hydro's hydroelectric generation stations. The incidence of pitting damage, the frequency of repairs, and maintenance costs are delineated.

34710 Modern trends in selecting and designing Kaplin turbines. de Siervo, F.; de Leva, F. (ELC-Electroconsult, Milan). *Int. Water Power Dam Constr.;* **30**: No. 1, 52-58(Jan 1978).

Results of an extensive investigation carried out on more than 130 Kaplan turbines manufactured all over the world are presented in the form of statistical diagrams providing engineers with the latest information for preliminary design of hydro powerplants. Spiral case size and draft tube size are considered, and a comparison is made between Francis and Kaplan turbines.

34711 Economical load distribution in hydrothermal integrated systems. Langer, U. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Projekttraeger Energieforschung). *Energiewirtsch. Tagesfragen;* **27**: No. 11, 731-734(Nov 1977). (In German).

This contribution makes use of an algorithm for economical load management modified on the basis of Pontryagin's maximum principle. The example considered relates to an integrated system consisting of five storage power plants connected in series and a thermal standby plant. For this reason, special attention is devoted to the disconnection capability of power plants below their lower limits of power range and the retention of the flowpath between the hydraulic power plants.

34712 Optimal control of hydro-electric power plants: problems, concepts, solutions. Reichert, K.; Schaffer, G.; Marculin, R.; Wettstein, F. *Brown Boveri Rev.;* **64**: No. 7, 388-397(Jul 1977).

The paper considers the problems of optimizing the control of hydroelectric power plants. It is shown how the methods and principles of systems engineering can be applied to these problems. The role of the computer in power system control and the necessary hardware and software requirements are discussed. An example of the application of the method of system analysis and systems engineering to the optimum control problems of an actual hydroelectric power plant is also included. 6 refs.

REGULATIONS AND LICENSING

34713 Dam safety in British Columbia. Hunt, H.M.; Round, R.P.D. (Dept. of the Environment, Victoria, British Columbia). *Int. Water Power Dam Constr.;* **30**: No. 1, 27-30(Jan 1978).

Many dams in British Columbia were built before 1900, and a comprehensive inspection and surveillance program has been developed. The background and implementation of this program are described. Topics discussed include program responsibilities, classification of dams, organization, the dam safety program, and coordination with other agencies. (PMA)

ECONOMICS AND MANAGEMENT

REFER ALSO TO CITATION(S) 34707

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 34707

34714 Environmental studies for Wreck Cove. Schiefer, K.; Eedy, W. (Beak Consultants Ltd., Mississauga, Ont.). *Int. Water Power Dam Constr.;* **30**: No. 1, 31-38(Jan 1978).

Some innovative technology was used to resolve some of the major environmental and resource use conflicts related to the building of a hydroelectric power plant. These innovations include: (1) flexibility in the synchronization of water movement between reservoirs; (2) laboratory simulation of bog decomposition; and (3) a riparian flow policy designed to relate to the specific biological requirements of downstream salmon populations. Topics discussed are project background, environmental conflicts, study guide lines, the water quality model, decomposition and toxicity studies, and riparian flow management. (PMA)

POWER CONVERSION SYSTEMS

REFER ALSO TO CITATION(S) 34834, 35307

34715 Mechanical braking of hydro-electric generator sets. Grgic, A. *Brown Boveri Rev.;* **64**: No. 7, 398-401(Jul 1977).

The run-down time for hydroelectric generator sets can be reduced by employing a braking facility. Depending on the type of machine and its duty, either mechanical or electrical automatic brakes may be used. The article describes the structure of mechanical brakes, various operational braking procedures and some possible precautions against brake dust. 3 refs.

34716 Application of mechanical brakes to hydro-electric generator sets. Grgic, A. *Brown Boveri Rev.;* **64**: No. 7, 402-409(Jul 1977).

Preliminaries which must precede the application of mechanical brakes to hydroelectric generator sets are enumerated. Reasons for normal and emergency braking are considered. The article concludes with optimized recommendations governing the application of mechanical brakes. For example, the braking process must be automatic although manual operation, whenever required, must also be possible. 6 refs.

34717 Telemetering applied to a hydro generator in Cabora Bassa. Emden, K.; Spielmann, R. *Brown Boveri Rev.;* **64**: No. 7, 410-413(Jul 1977).

This paper describes the application of telemetering for measuring the expansion of the laminated rim of a hydrogenerator, as a function of the speed, and also any oscillations there might be between the rim and its support key. On account of their size and unique design features it was decided to use one of the hydro generators of the Cabora Bassa power station in Mozambique for these measurements. The components of the neasuring system and the results obtained are presented.

34718 Strength calculations of blades of moving-blade and diagonal hydraulic turbines by the finite element method. Golovin, O.A.; Matveev, A.M.; Postoev, V.S.; Smelkov, L.L. (Cent Boiler and Turbine Inst, USSR). *Energomashinostroenie;* No. 8, 1-2(1977). (In Russian).

The problem of strength calculation of blades by the mixed finite element method is considered. The blade is regarded as an arbitrary thin shell. It is divided into a set of plane triangular elements. The coordinates of their apices are obtained by means of an algorithm in ALGOL language.

SOLAR ENERGY

34719 1977 solar energy and research directory. Ann Arbor, MI; Ann Arbor Science Publishers, Inc. (1977). 396p.

The Directory was compiled from Ann Arbor Science questionnaires distributed to individuals, companies and research facilities involved in solar activities. The Directory is composed of seven chapters whose titles reflect the entrant's major area of activity. Complete information for each entrant is listed in the chapter designated on the questionnaire as the Number 1 ranked major classification. Additional major classifications are also listed in order of entrant ranking. Major classifications are as follows: 1. Energy conservation; 2. manufacturers of solar components; 3. manufacturers of solar total systems; 4. distributors of solar products; 5. design/construction, residences or buildings; 6. solar research; and 7. solar energy-other related areas. Chapter 7 includes several categories suggested by respondents to our questionnaire. These are: agricultural applications, computers, consultants, education, information dissemination, plating, and wind energy systems. The Directory is also thoroughly cross-referenced. Where an entrant has indicated more than one major classification, a "line listing" of the company name appears in alphabetical order in the respective chapter. Also, the page number is provided, referring the reader to the complete listing.

RESOURCES AND AVAILABILITY

34720 Skylight book. Capturing the Sun and the Moon: a guide to creating natural light. Burns, A. Philadelphia; Running Press (1976). 111p. .

The following topics are covered: planning; essential tools: hand and power; safety hints; curb installation; plexiglas or plate glass skylight; the plexiglas box skylight; tips on working with plexiglas; checking for leaks; framing the shaftway; electric work; shaftwall insulation; covering the shaftway with drywall; other kinds of wall coverings; internal storm windows; plants under your skylight; skylight manufacturers; and places to buy things. There are 38 pages of pictures of the use of skylights. (MHR)

ECONOMICS

REFER ALSO TO CITATION(S) 34734

SOLAR ENERGY CONVERSION

PHOTOVOLTAIC CONVERSION

34721 (TID—27913/1) **Thin films of silicon on low-cost substrates. Quarterly report No. 2, October 1, 1976—December 31, 1976.** Baghdadi, A.; Gurtler, R.W.; Keeling, M.C. (Motorola, Inc., Phoenix, Ariz. (USA). Solar Energy Dept.). Jan 1978. Contract EY-76-C-03-1287. 24p. Dep. NTIS, PC A02/MF A01.

The objective of this research program is to investigate the deposition of silicon on a low cost or temporary substrate using an Energy Beam. Construction of the major apparatus for investigation of the Energy Beam deposition of Si is almost completed. A spectrum of the Energy Beam plasma was obtained in the region 2,000A—8,000A; analysis of an N_2 band system of the spectrum yielded a vibrational temperature for the plasma of 4300 K. Initial experiments using SiH_4 in the Energy Beam plasma have produced encouraging results.

34722 Thin-film gallium arsenide solar cells on tungsten/graphite substrates. Chu, S.S.; Chu, T.L.; Yang, H.T. (Southern Methodist University, Dallas, Texas 75275). *Appl. Phys. Lett.;* **32**: No. 9, 557-559(1 May 1978).

Polycrystalling gallium arsenide films deposited on tungsten/graphite substrates by the reaction of gallium, hydrogen chloride, and arsine have been used for the fabrication of MOS-type solar cells. The deposited films were oxidized in situ with an argon-oxygen mixture and, in some cases, followed by a water-vapor treatment. Gold was used as the barrier metal, and titanium oxide

was used as the antireflection coating. Large-area (6—9 cm^2) solar cells with an AM1 efficiency of about 5.5% have been produced.

34723 Anomalous temperature dependence observed on the photovoltage of Se-based amorphous thin film-SnO_2 heterostructures. Nang, T.T.; Okuda, M.; Matsushita, T.; Suzuki, A. (Department of Electrical Engineering, College of Engineering, University of Osaka Prefecture, Mozu, Saki, Osaka, Japan). *Appl. Phys. Lett.;* **32**: No. 8, 489-490(15 Apr 1978).

The temperature dependence of the photovoltage of Se-based amorphous thin film-SnO_2 heterostructures has been studied over a temperature range of 77-393 °K. An anomalous temperature dependence of the photovoltage was observed, i.e., for a constant light intensity, the photovoltage initially increases with increasing temperature, reaches a maximum value at some temperature, and therefore decreases with further increase in temperature.

34724 Photovoltaic properties of ZnCdS/CdTe heterojunctions prepared by spray pyrolysis. Yin, S.; Fahrenbruch, A.L.; Bube, R.H. (Department of Materials Science and Engineering, Stanford University, Stanford, California 94305). *J. Appl. Phys.;* **49**: No. 3, 1294-1296(Mar 1978).

A series of photovoltaic heterojunctions of the type n-Zn/sub 0.1/Cd/sub 0.9/S/p-CdTe have been prepared by spray pyrolysis of ZnCdS films on single-crystal CdTe with variation of the CdTe substrate temperature and of the postdeposition heat-treatment temperature in hydrogen. Open-circuit voltages as high as 0.82 V are observed compared to maximum values of 0.74 V observed for n-CdS/p-CdTe junctions also prepared by spray pyrolysis. Cell efficiencies are in the 6-8% range without correction for reflection losses.

34725 Solar battery. Tarui, Y.; Sakamoto, T.; Komiya, Y. (to Agency of Industrial Science and Tech.). US Patent 4,046,594. 6 Sep 1977. Priority date 19 Jun 1975, Japan. 6p.

Disclosed is a solar battery comprising a multi-layered "p-n" junction structure, which has a plurality of inwardly converging recesses to partially expose the inner "p-n" junctions to the sun light.

34726 Flexible solar generator panel. Ruesch, D. (to Licentia Patent-Veraultungs-G.m.b.H.). US Patent 4,043,834. 23 Aug 1977. Priority date 18 Sep 1975, German, Federal Republic of (F.R. Germany). 4p.

A solar generator panel for satellite and terrestrial energy supply systems comprises a flexible support having a plurality of solar cells mounted on the support and being rollable and foldable therewith. Connector means are provided for electrically interconnecting the cells in either parallel or series. At least one conducting layer is applied to the opposite side of the support from the solar cells and is adapted to be grounded to the associated satellite or to the earth for the purpose of eliminating charged carriers. The back of the assembly is advantageously provided with a layer of adhesive mixed with electrically conducting particles and particularly silver powder particles which serve to connect the solar cells through to the satellite. The proportion of the electrically conductive particles in the adhesive layer is preferably about 50%.

34727 Machine for welding solar cell connections. Lorans, D.Y. (to Societe Anonyme de Telecommunications). US Patent 4,041,271. 9 Aug 1977. Priority date 10 Jan 1975, France. 4p.

A machine for welding a connection wire over a solar cell electrode is described which comprises a base, a welding mount for the solar cell which is supported on the base, means for holding the solar cell on the welding mount, welding electrodes, means to lower the welding electrodes over the solar cell and the connection wire superimposed thereon, means for applying electric current pulses to said welding electrodes. It is characterized by the fact that it further comprises means for imparting to said mount an alternating transverse movement in relation to said base before and during the welding operation.

34728 Solar collector having a solid transmission medium. Schertz, W.W.; Zwerdling, S. (to Energy Research and Development Administration). US Patent 4,029,519. 14 Jun 1977. Filed date 19 Mar 1976. 6p.

PAT-APPL-668,345.

There is provided a radiant energy transmission device capable of operation in a concentrative mode in which energy incident on an entrance area is directed toward and concentrated on an exit area of smaller area than the entrance area. The device includes a solid radiant energy transmission medium having surfaces coincident with the entrance and exit areas and particularly contoured reflective side walls. The surface coinciding with the entrance area is coupled to a cover plate formed of a radiant energy transmissive material. An energy transducer is coupled to the surface of the medium coinciding with the exit area.

34729 Photovoltaic energy conversion using concentrated sunlight. Burgess, E.L. (Sandia Lab, Albuquerque, NM). *Opt. Eng.;* **16**: No. 3, 305-312(May-Jun 1977).

A development program is described in which sunlight concentration techniques are used to effect an immediate reduction in cost-per-unit power for photovoltaic systems in which solar cell cost dominates the total system cost. Current examples of concentrator solar cell technologies are single crystal silicon and gallium arsenide. Implementation of cost reductions by the use of sunlight concentration is not dependent on the development of low-cost, mass-production cell technologies but emphasizes high cell efficiency and low-cost concentrator systems. 12 refs.

34730 Thin-film structures with Cu_2S—CdS heterojunction. Akramov, Kh.T.; Stashkov, G.M.; Yuldashev, B.D.; Vishchakas, Yu.K. (Tashkent State Univ.). *Appl. Solar Energy (USSR) (Engl. Transl.);* **12**: No. 4, 2-6(1976).

Translated from Geliotekhnika; 12: No. 4, 5-10(1976).

Results are reported for studies aimed at developing and creating photocells based on CdS films obtained by the gas-transport reaction method. The CdS base film was investigated. It is shown that the films have ideal structure, while their chemical composition is nearly stoichiometric. The technology for fabricating Cu_2S-Cds film heterojunctions by immersion of CdS layers in an aqueous solution of CuCl is analyzed. The way in which the properties of heterojunctions are affected by manufacturing factors is considered in detail. Sample photoconverters have been manufactured. Values of U/sub nl/ = 0.4-0.45 V and I/sub sc/ = 4-6 mA have been obtained under solar illumination, with a factor $\gamma = 0.5$-0.7.

BIOMASS PRODUCTION AND CONVERSION

REFER ALSO TO CITATION(S) 34703, 34704

PHOTOCHEMICAL AND THERMOCHEMICAL CONVERSION

34731 Solar energy and the hydrogen economy: analysis of schemes for producing hydrogen. Sheklein, A.V. *Appl. Solar Energy (USSR) (Engl. Transl.);* **12**: No. 4, 61-67(1976).

Translated from Geliotekhnika; 12: No. 4, 81-89(1976).

The analysis is based on the assumption that the most promising method for producing hydrogen is the one that provides the product at the lowest cost. The following schemes are considered for obtaining hydrogen by using solar energy as the primary source: (a) electrolysis of water by an electric current generated by direct conversion of solar radiant energy into electric energy by means of solar rays; (b) electrolysis of water by an electric current generated by a thermal solar plant in a conventional steam cycle; (c) thermochemical decomposition of water using solar energy to heat the vessel and (d) direct photocatalytic decomposition of water by solar radiation. The economics of each scheme is discussed.

PHOTOVOLTAIC POWER PLANTS

REFER ALSO TO CITATION(S) 35329

SOLAR THERMAL POWER PLANTS

REFER ALSO TO CITATION(S) 35329, 35352

34732 Composition method for constructing guaranteed-output curves of solar- and wind-power plants utilized jointly. Salieva, R.B. (Tashkent Electrotechnical Inst. of Communications). *Appl. Solar Energy (USSR) (Engl. Transl.);* **12**: No. 4, 39-42(1976).

Translated from Geliotekhnika; 12: No. 4, 52-56(1976).

A composition-plot method is considered for the resultant guaranteed-output curve of solar- and wind-power plants operated jointly for power and water-supply purposes.

CENTRAL RECEIVER

REFER ALSO TO CITATION(S) 34755

34733 (SAN—1109-8/9) **Solar Pilot Plant, Phase I: preliminary design report. Volume VII. Pilot plant cost, commercial plant cost and performance. CDRL item 2.** (Honeywell, Inc., Minneapolis, Minn. (USA). Energy Resources Center). 1 Jun 1977. Contract EY-76-C-03-1109. 140p. Dep. NTIS, PC A07/MF A01.

Portions of document are illegible.

Cost estimates are presented for the Solar Pilot Plant by cost breakdown structure element, with a commitment schedule and an expenditure schedule. Cost estimates are given for a Commercial Plant, including several point costs for plants with various solar multiples and storage times. Specific questions (ERDA) pertaining to commercial plant design and performance data are addressed. The

cost estimates are supplemented by two books of vendor and subcontractor cost data.

SOLAR RADIATION UTILIZATION

34734 Solar energy utilization in the UK: current research and future prospects. Courtney, R.G. *Archit. Sci. Rev.;* **19**: No. 2, 44-49(Jun 1976).

Energy supply and consumption in the UK are outlined briefly and the main characteristics of solar radiation received are discussed. Current research into the use of solar energy for space heating or the provision of domestic hot water is reviewed and existing and proposed solar installations are listed. Although the prospects for widespread use of solar energy for space heating in the UK are uncertain, those for solar assisted water heating systems appear to be more promising.

SPACE HEATING AND COOLING

REFER ALSO TO CITATION(S) 35308

34735 (EPRI-EM—313-SR, pp 2.18-2.21(Vol.I)) **Solar heating and cooling of buildings: a utility perspective.** Cummings, J.E. 1976.

From EPRI workshop on technologies for conservation and efficient utilization of electric energy; San Diego, CA, USA (26 Jul 1976).

In Proceedings of an EPRI workshop on technologies for conservation and efficient utilization of electric energy. Volume I. Executive summary; Volume II. Working papers.

The EPRI research program for developing, demonstrating and evaluating solar heating and cooling systems for buildings is described. (LCL)

34736 Solar cooling of a Florida Welcome Station: a demonstration. Lowery, G.W. (Florida Solar Energy Center, Cape Canaveral). pp 4.18-4.22 of Proceedings of the fourteenth space congress on space technology for better living. Canaveral, FL; Canaveral Council of Technical Societies (1977).

From 14. space congress proceedings; Cocoa Beach, FL, USA (27 Apr 1977).

See CONF-770468—.

One of two commercial solar heating and cooling demonstration projects supported by ERDA in Florida is under construction at the Visitor Welcome Station on Interstate Highway 95 north of Jacksonville. The 3,300 square-foot Welcome Station will be retrofitted with a 25-ton absorption chiller to take most of the load from the existing conventional air conditioner. Twenty seven hundred square feet of tracking, concentrating collectors using linear Fresnel lenses will be mounted on the ground away from the building. To drive the air conditioner during short sunless periods solar heated water will be stored in a 6,000 gallon tank. Another 6,000 gallon tank will be used to store chilled water. An anticipated 88 percent of the cooling load will be furnished by the solar system when it is completed in mid-1977. Instrumentation will be included to compare performance with design conditions and to acquire solar irradiance design data for that geographical area.

34737 (TID—27804) **Paths to solar heating and cooling. A proposed program plan for research and development in solar heating and cooling.** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Solar Energy). 2 Aug 1976. 201p. Dep. NTIS, PC A10/MF A01.

The ERDA R and D plan described is one of the initiatives of the ERDA solar heating and cooling programs. These initiatives are: (1) directed R and D resulting in reduced costs and improved efficiency of solar systems; (2) direct market stimulus to aid in creating a large-enough market to insure increasing participation by industry; this stimulus is represented by a major solar hot-water initiative in both the public and private sectors, linked to retrofit applications in commercial and residential buildings; and (3) direct manufacturing stimulus, considering the spectrum of approaches ranging from guarantees to the design or construction of pilot-production facilities as an incentive for the production of solar systems. The program plan consists of ten different paths (approaches) to the utilization of solar energy for the following specific applications: (a) service hot water (2 paths); (b) space heating (4 paths); and (c) space cooling (4 paths). Each path has a single objective: to develop the cost-effective technology to achieve in the most expeditious fashion (i) service hot water, (ii) space heating, or (iii) space cooling. Combination of applications, such as space and water heating or space heating and cooling, are generally straightforward combinations of two or more paths. Furthermore, the space-heating paths will also include space and hot-water heating. An exception to this may be made in the use of passive systems or certain special applications. The program objectives, structure, and plan are presented in detail.

34738 Frank M. Ours, self-sufficient workshop and greenhouse. Moran, E. *Pop. Sci.;* **212**: No. 2, 38, 40(Feb 1978).

Information is presented concerning the use of sunlight to heat utility buildings or greenhouses by use of building orientation and configuration with skylights and reflectors.

34739 You can build NASA's low-cost solar heating system. Gross, G. *Pop. Sci.;* **212**: No. 2, 106-108(Feb 1978).

Information is presented concerning the general specifications, materials, and cost for a solar space heating system designed by NASA for use in homes as a supplement to existing heating systems.

34740 Passive solar heating and cooling systems. Yellott, J.I. (Arizona State Univ., Tempe). *ASHRAE J.;* **20**: No. 1, 60-67(Jan 1978).

From Symposium on passive systems for solar utilization; Halifax, NS, Canada (1977).

There are three principal passive heating systems, using the following concepts: Type 1 - sun + space + building mass storage; Type 2 - sun + storage mass + space, and Type 3 - sun + natural convection + storage. Type 1 is exemplified by the David Wright residence. Type 2 examples are the Trombe wall residences and the Steve Baer drumwall houses. The Skytherm houses are a type 2 which can both heat and cool. Type 3 includes the thermosyphon water heater and the Paul Davis house. Details and data are included for some of these houses. (MHR)

34741 Solar energy utilization for residential heating. *Plumb. Heat. J.;* **54**: No. 6, 11-12(Nov 1974).

System derived from space technology is illustrated using solar energy for residential cooling and heating in Marshall Space Flight Center, Alabama.

AGRICULTURAL AND INDUSTRIAL PROCESS HEAT

34742 Use of solar energy to cure peanuts. Butler, J.L.; Troeger, J.M. St. Joseph, MI; American Society of Automotive Engineers (1977). 10p.

Within the peanut belt, almost any south facing roof slope can be effectively used to mount a solar energy collector. At near the mid-latitude, the average daily insolation on a horizontal surface can be expected to range from about 13,400 KJ/m² to 17,300 KJ/m² during the normal peanut drying season. Test results are reported that indicate, on the average, from 50-60 percent of the heat energy for drying peanuts can be supplied by solar energy. Some form of energy storage is desirable so that drying may continue when the sun is not shining. Although the temperature range of the air supplied by solar energy exceeded the recommendations, for a portion of the drying time, there were no significant differences between these and the conventional systems.

34743 Solar curing facilities for burley tobacco. Walton, L.R.; Henson, W.H. Jr.; McNeill, S.G.; Parker, B.F.; Bunn, J.M. St. Joseph, MI; American Society of Automotive Engineers (1977). 18p.

A solar curing structure consisting of four types of forced ventilation curing chambers was used to cure burley tobacco during the Fall 1976. The objective was to use solar heat to reduce high relative humidity during curing. The chambers were a conventional chamber with metal roof, a transmitting-roof chamber with a fiberglass roof, a solar-collector-no-storage chamber, and a solar-collector-rockbed-storage chamber. The average daily relative humidity was up to 5 percentage points less in the transmitting-roof chamber and the solar-collector-no-storage chamber as compared to the conventional chamber. The solar-collector-rockbed system supplied enough heat to reduce the relative humidity from the 80 to 90% range to the desired 65 to 70% range for 3 days of rainy weather. Among the conclusions reached are that the solar-collector-rockbed-storage system for curing burley tobacco was superior to a solar-collector-no-storage system and a transmitting-roof system because it provided heat to modify the environment during critical periods of high humidity. The rockbed provided an adequate heat supply for three days without replenishing. 14 refs.

WATER HEATING

REFER ALSO TO CITATION(S) 34737, 35353

34744 (TID—28291) **Double-exposure collector system. Technical progress report, September 30, 1977—December 30, 1977.** Larson, D.C.; Savery, C.W. (Drexel Univ., Philadelphia, Pa. (USA)). 14 Feb 1978. Contract EG-77-G-04-4089. 21p. Dep. NTIS, PC A02/MF A01.

A retrofit solar water-heating system has been installed in a three-story apartment building at Drexel University. The system employs two conventional collector banks (10 PPG collectors) mounted at the latitude angle for Philadelphia of 40 deg from the horizontal and two double-exposure collectors (DEC's) mounted vertically in mirrored enclosures. Although the DEC units are being

used for year-round domestic water heating for the building, they are designed to provide maximum output in the winter and are therefore well-suited to solar space heating applications. The performance of the DEC units relative to conventional collectors has been calculated for both a fixed-mirror and an adjustable-mirror configuration. Instrumentation for testing the DEC units performance has been developed and is presently being installed in the apartment building. Preliminary measurements have been obtained, however, of the useful heat output of the DEC units relative to the PPG collectors; these data were obtained on two clear and cold days in December 1977. On these days the DEC units delivered 5.6 to 9.1 times more heat per panel area than the PPG collectors as the PPG collector efficiency varied from 30.2 to 11.9%.

34745 Solar energy augmented water heating system. Honikman, T.C. US Patent 4,052,000. 4 Oct 1977. Filed date 19 Apr 1976. 14p.

Solar energy is utilized to augment the heater of a water heating system, such as a domestic hot water system, having a water storage and heating tank by conducting water to the tank through a solar energy storage tank and circulating a heat transport liquid through a solar collector and selectively through the solar tank and water tank in response to the collector temperature, the solar tank temperature, and the water tank temperature, in a manner such that heat transport liquid flow occurs in a normal solar energy storage mode through the collector and the solar tank under a first set of temperature conditions, and cascade fashion through the collector, the water tank, and then the solar tank in a cascade solar energy storage mode under a second set of temperature conditions and in a maximum solar energy storage mode under a third set of temperature conditions. Heat transport liquid flow may occur through the solar collector and solar tank in response to a preset low collector temperature to prevent freezing of liquid in the collector, and the water tank heater may be shut off in response to a high collector and water temperature condition to conserve energy. The invention also provides novel solar collector and tank heat exchanger structures for the heating system.

OTHER

REFER ALSO TO CITATION(S) 34762

34746 Solar reactor engine. Scragg, R.L.; Parker, A.B. US Patent 4,026,112. 31 May 1977. Filed date 10 Feb 1976. 8p.

A solar reactor engine is disclosed which includes a concrete or other suitable housing having a reactor chamber therein. In one embodiment, the reactor chamber is cylindrical. A solar intensifier, such as a parabolic reflector, is mounted on top of the reactor housing. The parabolic reflector collects and intensifies solar rays and guides them down through a solar sight glass, mounted on top of the housing, into the reactor chamber. The concentrated beam of light is directed onto a reflector cone within the reactor chamber which disperses solar rays throughout the chamber. Hydrogen and chlorine are conducted into the reactor chamber and react with controlled explosive violence when exposed to the solar rays. Atmospheric oxygen is used as a control medium to regulate the energy given off by the reaction of the hydrogen and chlorine in the presence of solar energy. The heat and pressure thus formed are utilized to drive a turbine, the output of which is utilized to drive a suitable utilization device. In another embodiment of the invention, the solar reactor engine is housed in a metal or other suitable housing so that the reactor engine can be utilized for propulsion or mobile applications.

34747 Solar reactor engine. Scragg, R.L.; Parker, A.B. US Patent 4,024,715. 24 May 1977. Filed date 20 Jun 1975. 6p.

A solar reactor engine is disclosed which includes a concrete or other suitable housing having a reactor chamber therein. In one embodiment, the reactor chamber is cylindrical. A solar intensifier, such as a parabolic reflector, is mounted on top of the reactor housing. The parabolic reflector collects and intensifies solar rays and guides them down through a solar sight glass, mounted on top of the housing, into the reactor chamber. The concentrated beam of light is directed onto a reflector cone within the reactor chamber which disperses solar rays throughout the chamber. Hydrogen and chlorine are conducted into the reactor chamber and react with controlled explosive violence when exposed to the solar rays. Oxygen is used as a control medium to regulate the energy given off by the reaction of the hydrogen and chlorine in the presence of solar energy. The heat and pressure thus formed are utilized to drive a turbine, the output of which is utilized to drive a suitable utilization device. In another embodiment of the invention, the solar reactor engine is housed in a metal or other suitable housing so that the reactor engine can be utilized for propulsion or mobile applications.

34748 Solar welding of oxide ceramics with metals in oxidizing atmosphere. Smokovdina, G.S.; Vartanyan, A.V.; Shakhparonyan, V.V. *Appl. Solar Energy (USSR) (Engl. Transl.);* **12**: No. 4, 36-38(1976).

Translated from Geliotekhnika; 12: No. 4, 47-51(1976).

Results are reported for investigations of the interaction of β-alumina with metals at the contact site for fusion in an oxidizing atmosphere (in air). A direct-tracking solar unit with 1.5-m diameter concentrator was used.

34749 Chemical investigation of water distilled by film solar plants. Achilov, B.M.; Norov, E.Zh.; Kamaeva, G.B. (Physical-Technical Inst., Tashkent). *Appl. Solar Energy (USSR) (Engl. Transl.);* **12**: No. 4, 68-69(1976).

Translated from Geliotekhnika; 12: No. 4, 90-91(1976).

The results of investigations of salt water distilled in solar plants made of various film materials are considered. The influence of these materials on the ion composition of the distillate obtained following treatment is examined. The qualitative and quantitative compositions are given for the initial water and the distillate.

SOLAR COLLECTORS AND CONCENTRATORS

REFER ALSO TO CITATION(S) 34728, 34729

34750 Low temperature ambient-plus solar collectors. Perberton, E.V. (Laurier Univ., Waterloo, Ont.); Remick, C.D. *ASHRAE J.;* **20**: No. 1, 57-59(Jan 1978).

The various temperature groupings of solar collectors are discussed. The collector energy balance and efficiency equations are presented. Applications of low temperature ambient-plus collectors are discussed with emphasis on swimming pool heaters and solar-assisted air-to-air heat pump space heating. Construction of such heaters is discussed briefly. (MHR)

34751 Solar radiation collection system. Knoos, S. US Patent 4,054,124. 18 Oct 1977. Filed date 6 Apr 1976. 22p.

High efficiency solar radiation collectors may employ a dual flow path relative to heat transfer surfaces of the collector panel. A major air flow is confined beneath tha panel, but a subsidiary (bypass) air flow at an angle to the principal air flow is also employed to suppress natural (free) flow convection at an upper side of the panel. Advantageously, the subsidiary air flow can be established by perforations in the collector panel and by creation of a suction for the bypass air. High efficiency energy collection, particularly adapted to weak and intermittent radiation environments, is further enhanced by the usage of a collector panel having a low thermal mass and providing good thermal interchange with a relatively small air mass moving beneath and above the panel, while being arranged to limit thermal conduction along the panel in the direction of air flow. Thus, a thermal gradient is established along the length of the collector panel, with a low temperature differential with the heated air mass at every position, with a fast heating response time, and with reradiation losses being minimized. By recirculating the air in a low thermal mass heat exchange system with an energy storage system in such fashion that inlet fluid is at the lowest sustainable temperature, insolation incident upon the collector is more fully utilized. The thermal energy storage most advantageously comprises what may be termed a minimum entropy system, with thermal energy in the heated air mass being interchanged in counterflow relation with a storage fluid which may be fed to different temperature level storages, dependent upon the intensity of the solar radiation available to the collector.

34752 Solar heat easily measured. Abel, K. (Fachhochschule Luebeck (Germany, F.R.)). *Elektr. Energ. Tech.;* **22**: No. 5, 241-242(Oct 1977). (In German).

The basic principle of measurement of the heat transported to the heat exchanger is explained. Also, the efficiency of a collector is discussed.

34753 Solar heater with automatic venting. Scott, P.B. (to Xonics, Inc.). US Patent 4,046,134. 6 Sep 1977. Filed date 26 Aug 1976. 4p.

An apparatus for collecting solar energy is described wherein a heat exchange array of plastic or the like is protected against damage by excessive heat buildup. The array is housed in a normally closed chamber having a portion transparent to solar rays and the chamber is periodically vented by means responsive to heat expansion of the enclosed array. The invention permits substantial cost reductions in solar heat exchanges; particularly of the type adapted to heat buildings, swimming pools and domestic water systems.

34754 Solar energy collecting device. Izumi, T.; Chiba, S.; Kobayashi, K. (to Hitachi Chemical Co., Ltd.). US Patent 4,046,136. 6 Sep 1977. Priority date 26 May 1975, Japan. 6p.

A solar energy collecting device is described comprising a hollow plastic panel as the heating element. The panel has opposite ends converged to provide tubular end portions each being inserted into and axially slidably supported by a tubular stud of a header. A

pair of headers is provided at opposite ends of said hollow plastic panel.

34755 Solar heat collector. Cooper, N.E. US Patent 4,043,315. 23 Aug 1977. Filed date 3 Feb 1976. 4p.

An omni-directional solar heat collector is described having a transparent, spherical outer shell, a spherical inner shell within the outer shell containing a plurality of light magnifying lenses spaced along the periphery thereof, and a plurality of heat collecting elements within the inner shell spaced from the magnifying lenses so that the maximum light and heat intensity focuses upon the elements.

34756 Solar collector unit. Kloos, J. German(FRG) Patent 2,551,987/A/. 26 May 1977. 7p. (In German).

A flat collector is described, which is to achieve optimum efficiency and which makes rational manufacture possible. The collector has a simple construction, is reasonably priced and is supplied as a pre-manufactured unit, ready to use, so that no further manual work at site is necessary. The absorber plate is structurally changed by chemical or mechanical treatment before blackening, so that fine capillaries are formed, which produces a matt, non-reflecting blackening, and the heat re-radiation of the black body is reduced, by the re-radiation partly hitting the capillary walls, and being made useful in this way. A vacuum is produced above and below the absorber plate to improve heat insulation.

34757 Characterization of the reflected beam profile of solar mirror materials. Pettit, R.B. (Sandia Lab, Abuquerque, NM). *Sol. Energy;* **19**: No. 6, 733-741(1977).

The absolute specular reflectance of flat mirrors was obtained as a function of the reflected beam width from 1 mrad to 17 mrad using a bidirectional reflectometer. The characteristics, calibration and advantages of this reflectometer are discussed. The mirror materials studied include samples of silvered glass, metallized plastic films and polished, bulk aluminum obtained from a variety of commercial suppliers. For some of these materials, the reflected beam profile could be described by a single normal distribution. However, for the other materials, the reflected beam profile was described by the sum of two normal distributions. Examples of the curve fitting procedure and data for selected materials are presented. 10 refs.

34758 Evaluation of portable optical property measurement equipment for solar selective surfaces. Pettit, R.B. (Sandia Lab, Albuquerque, NM). *Am. Soc. Mech. Eng., [Pap.];* No. 77-WA/SOL-1, 1-8(1977).

The operation and accuracy of portable optical measurement equipment for determining the solar absorptance, α/sub s/, and emittance, ϵ, of solar selective surfaces are presented. The optical equipment includes a Gier Dunkle Solar Reflectometer (Model MS-251) and a Willey Alpha Meter (Model 2150) for α/sub s/ measurements and a Gier Dunkle Infrared Reflectometer (Model DB-100) and a Willey Ambient Emissometer (Model 2158) for ϵ measurements. The accuracy of the M-251 for measurements of $alpha$$sub s$ for electrodeposited black chrome coatings was determined to be better than +-0.03 absorptance units. For the same coatings, the Willey Alpha Meter accuracy was limited by deviations up to 0.11 absorptance units. The accuracy of the Gier Dunkle Infrared Reflectometer for ϵ(100°C) measurements is better than +-0.02 emittance units. Values for ϵ(100°C) determined with the Willey Emissometer using black chrome coatings are higher than the actual 100°C emittance. However, since the relationship is linear, the correct emittance can be calculated by multiplication by a constant factor. 13 refs.

34759 Solar energy collector. Brin, R.L.; Pace, T.L. US Patent Application 734,839. 22 Oct 1976. 6p.

The invention relates to a solar energy collector comprising solar energy absorbing material within a chamber having a transparent wall. Solar energy is transmitted through the transparent wall, and efficiently absorbed by the absorbing material, for transfer to a heat transfer fluid. The solar energy absorbing material, of generally foraminous nature, absorbs and transmits the solar energy with improved efficiency.

34760 Distribution of radiant vector in radiation field of spherical concentrators. Zakhidov, R.A.; Vainer, A.A.; Gafurov, A.M. (Physico-Technical Inst., Tashkent). *Appl. Solar Energy (USSR) (Engl. Transl.);* **12**: No. 4, 7-10(1976).

Translated from Geliotekhnika; 12: No. 4, 11-15(1976).

The concentration of solar energy by a spherical mirror has been studied. It was found that the maximum irradiance at an ideal concentrator is as much as 0.277 of the focal irradiance of an ideal paraboloidal concentrator with 60° flare angle and identical coefficient of specular reflection. It is shown that it is desirable to replace a long-focus paraboloidal mirror (U/sub m/ approximately equal to 30°) by a spherical mirror.

34761 Concentrating power of paraboloidal facets. Umarov, G.Ya.; Zakhidov, R.A.; Khodzhaev, A.Sh. (Central Design and Design Engineering Bureau for Scientific Instrument Construction, Tashkent). *Appl. Solar Energy (USSR) (Engl. Transl.);* **12**: No. 4, 11-15(1976).

Translated from Geliotekhnika; 12: No. 4, 16-21(1976).

The formation of the image figure of an off-axis, infinitely remote point source by a paraboloidal mirror is considered. Formulas are obtained for calculating the coordinates of the points at which the reflected rays intersect a plane perpendicular to the rays incident on the mirror. Intersection-point coordinates calculated by means of a M-222 computer are used to construct the image figures and aberration diagrams on various planes for mirrors differing in flare angle at different ray angles of incidence.

34762 Engineering method for calculating the temperature field of a flat stationary receiver located at the focus of a paraboloidal concentrator. Akhmedov, A.R.; Smol'skii, G.V. (Inst. of Electronics, Tashkent). *Appl. Solar Energy (USSR) (Engl. Transl.);* **12**: No. 4, 16-20(1976).

Translated from Geliotekhnika; 12: No. 4, 22-28(1976).

A method is proposed for calculating temperature fields up to the melting point when concentrated solar radiation acts on flat stationary receivers for total melting. The method may be used for receivers made of various metals with one-piece paraboloidal concentrators of various diameters and manufacturing precisions being used.

34763 Sun position sensors using light selectors. Baranov, V.K. *Appl. Solar Energy (USSR) (Engl. Transl.);* **12**: No. 4, 21-24(1976).

Translated from Geliotekhnika; 12: No. 4, 29-33(1976).

It is shown that by combining a fiber light selector with some given radiation receiver it is possible to develop a small sun-position sensor offering several advantages over conventional sensors. Results are reported for tests of a model of such a device; they confirm that the device has a sharply limited field of view and that it may be used as a light-source position sensor. Fiber or stratified selectors, combined with fiber light-pipes, form a device for recording the position of the sun and its displacements. The head of this device may be installed on a moving platform and the recording part on a stationary base. The instrument may have an extremely large field of view.

34764 Joint action of forced and free convection in laminar flow past a flat plate. Davletov, A.; Khamadov, A. *Appl. Solar Energy (USSR) (Engl. Transl.);* **12**: No. 4, 25-28(1976).

Translated from Geliotekhnika; 12: No. 4, 34-37(1976).

A Karman--Pohlhausen solution is given to the boundary-layer equation for joint action of forced and free convection in zero-pressure laminar flow past a vertical flat plate. The solution is obtained for both concordant and opposed flow with Pr = 1.

34765 Structure and optical properties of dielectric-metal-dielectric coatings. Koltun, M.M.; Faiziev, Sh.A.; Gaziev, U.Kh. (Physical Technical Inst., Tashkent). *Appl. Solar Energy (USSR) (Engl. Transl.);* **12**: No. 4, 33-35(1976).

Translated from Geliotekhnika; 12: No. 4, 43-46(1976).

The conditions for production of a ZnS-Ag-ZnS coating on glass are investigated, together with the influence of each of the three layers on the optical characteristics of the coating. It is shown that the lower antireflection film in a three-layer coating serves not only to reduce reflection from the glass-metal film interface, but also creates conditions for condensation of a metal layer with small structural defects to increase the conductivity of the coating and its integral reflection coefficient in the infrared region of the spectrum.

GEOTHERMAL ENERGY

RESOURCE STATUS AND ASSESSMENT

USA

34766 (PNL—2597) Survey and preliminary evaluation of potential geothermal energy applications for Riverside, California. Bloomster, C.H.; Fassbender, L.L.; Schilling, A.H.; Lippek, H.E. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Mar 1978. Contract EY-76-C-06-1830. 83p. Dep. NTIS, PC A05/MF A01.

A preliminary assessment of the potential applications for geothermal energy in Riverside, California, was made. This assessment includes both potential electrical and non-electrical applications, and focuses on the following factors: the location of nearby geothermal resources; characteristics of these resources; types of applications suited to each resource; technical and economic feasibility of these applications; the potential impact on the energy demand of each application, and potential deterrents to the utilization of geothermal energy for the most promising application. It is concluded that geothermal energy has a promising potential to supply electricity, space heating and cooling, and process heat to Riverside.

There are sufficient geothermal resources within 200 miles to supply the electrical requirements of Riverside for thousands of years. Depending on the particular reservoir involved, this electricity can probably be generated at costs ranging from 1 to 3 times the cost of conventional electric power generation. Over this distance, the additional unit cost for energy transmission should be comparatively small. The geothermal resource at nearby Arrowhead Hot Springs has the potential to supply space heating and cooling and process heat to Riverside for a hundred years. The technology for these non-electric uses is available. The cost of using geothermal energy for these applications is estimated at 1 to 2 times the cost of conventional fuels, depending on the population density of the service area. The most difficult problems in the possible use of geothermal energy in Riverside appear to be institutional difficulties in electric applications.

NON-USA

34767 Prospects for geothermal energy applications and utilization in Canada. Glass, I.I. (Univ. of Toronto). *Energy (Oxford);* **2**: No. 4, 407-428(Dec 1977).

Like the sun, the earth is a vast energy source. The utilization of this geothermal furnace is still in its infancy, the heat flow from the mantle to the surface (9×10^{-5} cal/cm^2/min; 0.063 W/m^2) is the energy equivalent to 2×10^{11} barrels of oil per yr (3×10^{10} tons or about fourfold greater than the present yearly total world energy consumption). Although today only local hot spots yielding dry and wet steam, and shallow hot-water sites are used economically, future technology may well lead to a much greater utilization. This will be done through additional imaginative and sophisticated exploitation of available regions of dry hot rock, geopressure-geothermal fields, and even deep areas of significant heat flow. Such potential utilization of geothermal resources should provide for relatively pollution-free, steam-generated electrical power, steam and hot-water for home and industry, mineral and chemical by-products, as well as numerous uses where hot water is required in agriculture, horticulture, fisheries, mining, pulp and paper, and other industries. Canadian developments in these areas are still relatively dormant. The problem areas are not of a technological nature but rather of an institutional type in passing a geothermal act that would provide the incentives for exploration and economical development.

34768 Heat for thousands of years. Delisle, G. *Kosmos (Stuttgart);* **73**: No. 10, 746-750(Oct 1977). (In German).

The heat content which is stored underground in the Federal Republic of Germany down to a technically reachable depth of 7,000 m, would be sufficient to cover the energy demand of the country for thousands of years. However, the rocks all act as thermal insulators due to their poor thermal conductivity. The Los Alamos Scientific Laboratory in New Mexico (USA) is therefore trying to produce large heat exchange surfaces in depth regions with rock temperatures of over 200°C using the hydraulic fracturing method. Water is pressed into the insulated part region of a borehole, and the water pressure is increased until the rock fractures. One hopes that by keeping up the pressure, by propagation of the fracture, cracked surfaces in the order of climension of square kilometers can be produced. If the crack is cut by a second borehole, then the water heated on the artificially produced rock surfaces can be removed and led to a power plant. Investigations into naturally heated deep rocks are also being carried out at present in research boring at Urach in the Federal Republic.

GEOLOGY, HYDROLOGY, AND GEOTHERMAL SYSTEMS

34769 Volcanoes as a source of geothermal energy. Heffington, W.M.; Kline, J.M.; Rottman, J.W. (Univ. of California, San Diego, La Jolla). *Energy (Oxford);* **2**: No. 4, 457-459(Dec 1977).

The thermal energy available from high-temperature magma is calculated to be 8×10^{14} kcal/km^3 and an upper bound for volcanic energy of 3×10^{18} kcal/volcano is determined. Approximately one-third of the energy may be obtained between about 750 and 1150°C (i.e., above the solidification temperature of the magma), while the remaining two-thirds is available from magma in the solid state between ambient and around 750°C. Gas dissolved in the magma possesses about 4% of the thermal energy and a large portion of that energy is potentially available as high-temperature steam. After removal of water, the gas remaining is a low-Btu gas with a heat of combustion of about 0.3 kcal/l. Utilization of both the thermal and combustion energy is the subject of current research projects.

34770 Thermal convection of water in a porous medium: effects of temperature- and pressure-dependent thermodynamic and transport properties. Straus, J.M.; Schubert, G. (Aerospace Corp., Los Angeles). *J. Geophys. Res.;* **82**: No. 2, 325-333(10 Jan 1977).

Natural convection of water in thick geothermal layers, across which there are temperature differences as large as 345 K and pressure differences as great as 1 kbar, is investigated. Complete account is taken of the variable thermodynamic and transport properties of water as well as of non-Boussinesq effects. The increase of thermal expansivity with temperature by as much as a factor of 70 and the decrease of viscosity by more than 1 order of magnitude are primarily responsible for the enhanced instability to convection of a water-saturated porous layer compared with a porous layer saturated with a Boussinesq fluid having the constant properties of surface water. The critical Rayleigh number, critical wave number, and streamline and isotherm patterns are determined at the onset of convection of temperature gradients of 25, 50, 75, 100, 150, and 200 K/km in layers as thick as 10 km. The critical surface Rayleigh number is reduced by as much as a factor of 31 below the value of $4\pi^2$ appropriate for a constant property Boussinesq fluid. Variable water properties thus allow convection to occur for smaller vertical temperature differences in rock of a given permeability or for smaller permeability at a given temperature difference. The horizontal scale of convection is somewhat reduced, and the flow is concentrated toward the bottom of the porous layer by effects of variable expansivity and viscosity.

USA

REFER ALSO TO CITATION(S) 34773, 34791, 36135

NON-USA

34771 Reykjanes Peninsula, Iceland, earthquake swarm of September 1972 and its tectonic significance. Klein, F.W.; Einarsson, P.; Wyss, M. (Lamont-Doherty Geological Observatory, Palisades, NY). *J. Geophys. Res.;* **82**: No. 5, 865-888(10 Feb 1977).

A temporary network of up to 23 short-period seismic stations operated on the Reykjanes Peninsula during the summer of 1972 and recorded an earthquake swarm consisting of more than 17,000 events. The area studied is the immediate landward extension of the Mid-Atlantic Ridge, and seismic processes are probably similar to those on submarine parts of the ridge crest. The Reykjanes Peninsula forms the transition between the Reykjanes Ridge and the south Iceland transform fault. The peninsula is essentially a leaky transform fault, and focal mechanism solutions are of both normal and strike-slip types. The 12-km-long seismic zone active during the 8-day swarm is defined by 2514 hypocenters, which are mostly between 2 and 5 km deep. Individual structures within the seismic zone include several seismic lineations or faults trending obliquely to the zone. Also visible are two aseismic zones, which may be either rigid blocks or low-rigidity regions, such as magma chambers. Thus the observed seismic zone is not a single fault; instead it appears to be the shallow expression of a deeper-seated and aseismic deformation zone. In time, the seismic events cluster together into subswarms lasting a few hours and migrate laterally at speeds of 1 to 2 km/d. The energy released is equivalent to that of a single event of Icelandic local magnitude 4.9, and the total fault area is close to that expected for a single earthquake of this size. Although the high microearthquake activity and swarm seismicity can be generally related to the presence of an adjacent geothermal area, the observed earthquakes do not locate in or outline the hydrothermal upwelling zone visible at the surface. This contribution is the first study to reveal the details of faulting during an ocean ridge earthquake swarm, both in space and in time.

GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY

GEOPHYSICAL TECHNIQUES AND SURVEYS

REFER ALSO TO CITATION(S) 34777

34772 (CONF-770440—, pp 528) **Effectiveness of geophysics in locating geothermal reservoirs.** Keller, G.V. (Colorado School of Mines, Golden). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

34773 (CONF-770440—, pp 583) **Evaluation of the geothermal potential on the hot springs of NW Virginia.** Geiser, P.A. (Univ. of Connecticut, Storrs); Costain, J.K. 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

34774 (CONF-7510172—P2, pp 1007-1015) **Application of the gradient/radiance characteristic function in the study of the thermal**

trend of volcanic areas. Tonelli, A.M. (Istituto per la Geofisica della Litosfera-C.N.R., Milan). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The quantitative evaluation of some thermal parameters typical of the volcanic areas characterized by fumarolic activity has individuated a function given by the ratio between the absolute value of thermal gradient and the radiance itself, whose histogram enables the volcanologist to monitor the situation of thermal transitory by comparing the data of two subsequent surveys. Two different situations of "anomalous" change is considered for the thermal power of conduction, the one related to the change of power with radius of the areas surrounding the fumaroles, the other connected with a temporal variation and directly dealing with the proper thermal transitory. Finally some considerations on the noticeable sensitivity of this "characteristic function" are expressed.

34775 (EPRI-ER—680) **Geothermal exploration techniques: a case study. Final report.** Combs, J. (Texas Univ., Richardson (USA). Center for Energy Studies). Feb 1978. 71p. Dep. NTIS, PC A04/MF A01.

The objective of this project was to review and perform a critical evaluation of geothermal exploration methods and techniques. The original intent was to publish the work as a handbook; however, the information is not specific enough for that purpose. A broad general survey of geothermal exploration techniques is reported in combination with one specific case study.

GEOCHEMICAL TECHNIQUES AND SURVEYS

34776 Determination of deuterium concentration in water. Morgan, T.D.; Regier, R.B. (to Phillips Petroleum Co.). US Patent 4,066,404. 3 Jan 1978. Filed date 2 Aug 1976. 6p.

Water samples having a predetermined concentration of deuterium are equilibrated with a hydrogen-containing reagent, methane, at such conditions as to allow migration of hydrogen and deuterium ions between the reagent and water. The reagent is then analyzed to determine the isotope ratio of molecules containing deuterium to those containing hydrogen. From the data, a correlation between isotope ratio and the concentration of deuterium in water is established. The sample of water having an unknown concentration of deuterium is then equilibrated under the same conditions with the same reagent. The equilibrated reagent is analyzed to determine mass isotope ratio, which is converted to deuterium concentration in water using previously established correlation. Deuterium concentration in water is then used for obtaining geothermal data.

34777 Geothermal prospecting in The Geysers-Clear Lake area, northern California. Goff, F.E. (Geological Survey, Menlo Park, CA); Donnelly, J.M.; Thompson, J.M.; Hearn, B.C. Jr. *Geology;* **5**: No. 8, 509-515(Aug 1977).

The geochemistry of thermal waters combined with mapping and geophysical studies have been used to define boundaries of the geothermal steam field in The Geysers-Clear Lake area, California. Chemical geothermometry and drill hole data imply that a 200°C hot-water geothermal system underlies much of the 2.0 to 0.01-m.y.-old Clear Lake Volcanics. Chloride concentrations and electrical resistivity define the concealed extent of Great Valley sedimentary rocks underlying the young volcanic cover. It is suggested that the 80 or more vents in the volcanic field act as permeable conduits for water recharge and thus prevent creation of a widespread vapor-dominated system northeast of the Collayomi fault zone.

34778 Drain of hot spring resource and its relation to overdraft of thermal water. II. Thermal springs of Yugashima and neighbouring area. Mashiko, Y.; Sato, K.; Kanroji, Y.; Tanaka, A. *Onsen Kogakkaishi;* **11**: No. 1, 1-21(1976). (In Japanese).

Yugashima spa is located on the north foot of Amagi volcano, in the central part of Izu Peninsula projecting from the south eastern foot of Mt. Fuji. Several spas such as Sagasawa, Yoshina, Tsukigase, Yaguma, Funabara, and Kakinoki are distributed in the north area of Yugashima spa. Thermal waters of these springs issue from the Yugashima propylites. Temperature, total amount of flow, and chemical characteristics of these spas examined in 1974 are tabulated.

EXPLORATORY DRILLING AND WELL LOGGING

34779 (COO—4081-2) **Development of passive electronic components for instrumentation of improved geothermal logging tools and components. Annual progress report.** Raymond, L.S.; Hamilton, D.J.; Kerwin, W.J. (Arizona Univ., Tucson (USA)). 20 Oct 1977. Contract EY-76-S-02-4081. 39p. Dep. NTIS, PC A03/MF A01.

Short term objectives for well-logging instrumentation are circuits which can operate at temperatures in the range 275°C to 350°C; the medium term goal is operation up to 500°C, and the long term goal is to achieve operation at 1000°C. It is apparent that useful electronic circuits will require the combination of both passive components and active devices. In order to meet the compatibility requirements, the basic technology which has been selected in this project is the chemical vapor deposition of metal interconnections, resistor material, dielectric material and passivating material. It is to be emphasized that this is a thin-film, not thick-film, technology which is compatible with the processing methods used in fabricating either semiconductor or integrated thermionic devices, and produces components which are electrically compatible with those devices. The investigation in this project is primarily directed toward tungsten metallization, tungsten-silicon resistors, and silicon nitride dielectric and passivation.

34780 (LA—7152-MS) **Equipment development report: borehole-fluid sampling tool.** Archuleta, J.R.; Fink, C.F.; Kurtenbach, J. (Los Alamos Scientific Lab., N.Mex. (USA)). Feb 1978. Contract W-7405-ENG-36. 32p. Dep. NTIS, PC A03/MF A01.

The design and development of a tool for collecting fluid samples from hot, deep geothermal boreholes are discussed. This tool has performed satisfactorily in the field at downhole temperatures of 200°C and pressures of 34.5 MPa (5000 psi). Assembly and operating instructions are included.

LEGAL AND INSTITUTIONAL ASPECTS

REFER ALSO TO CITATION(S) 34783

34781 (UCRL—52327) **Geothermal resource development: laws and regulations.** Wharton, J.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 Aug 1977. Contract W-7405-ENG-48. 67p. Dep. NTIS, PC A04/MF A01.

The development of geothermal resources in California is becoming of increasing interest because of the large amounts of these resources in the state. In response to this interest in development, the legislature and regulatory bodies have taken actions to increase geothermal power production. The important federal and California laws on the subject are presented and discussed. Pertinent federal and state provisions are compared, and inconsistencies are discussed. An important concept that needs clarification is the manner of designating an area as a "known geothermal resource area." The question of designating geothermal resource as a mineral is not completely resolved, although there is authority tending toward the finding that it is a mineral.

34782 Property rights to geothermal resources. Sato, S.; Crocker, T.D. *Ecol. Law Q.;* **6**: No. 2, 247-321(1977).

The current status of the property regime governing geothermal resources is examined and alternative regimes are investigated with a view to identifying that system which promotes the most efficient allocation of resources. First, the current status of proprietary claims to geothermal resources is explored. Second, the various property regimes which might be applied to geothermal resources are analyzed and a system based on government licensing is proposed. A brief technical discussion provides the geological and engineering information necessary to an understanding of the article. This is followed by a discussion of the property rights to geothermal resources in California's Imperial Valley. (MHR)

ECONOMIC AND FINANCIAL ASPECTS

REFER ALSO TO CITATION(S) 34795

ENVIRONMENTAL ASPECTS AND WASTE DISPOSAL

34783 (NP—22839) **California geothermal resource development environmental implications for ERCDC Environmental Analysis Office. Final report.** Roberts, J.A. (California Energy Resources Conservation and Development Commission, Sacramento (USA)). 1 Feb 1977. 154p. Energy Resources Conservation and Development Commission, Sacramento.

Portions of document are illegible.

The results of an analysis of the environmental implications for ERCDC Environmental Analysis Office (EAO) in relation to the development of California's geothermal resources are reported. While focusing primarily on environmental implications, particularly the natural, social, and economic elements, the report includes some ERCDC-wide policy and program considerations. The primary thrusts of the work have been in the development of an understanding of the interagency and intergovernmental environmental data and data-management roles and responsibilities and in the formulation of recommendations related thereto. Five appendices are includ-

ed, one of which is a tax credit agreement between a power company and Skagit County, Washington. (JGB)

34784 Atmospheric dispersion of heat and water vapor at the Imperial Valley geothermal fields. Kelly, R.E. (Univ. of Mississippi, University). *EOS, Trans., Am. Geophys. Union;* 56: No. 12, 988(1975).

GEOTHERMAL POWER PLANTS

DESIGN AND OPERATION

34785 (EPRI-ER—670) **Preliminary design manual for a Geothermal Demonstration Plant at Heber, California.** Holt, B.; Ghormley, E.L. (HOLT/PROCON, Pasadena, Calif. (USA)). Feb 1978. 149p. Dep. NTIS, PC A07/MF A01.

A preliminary design of a 50 MWe Geothermal Demonstration Plant for Heber, California is presented. A site description, design basis, process design, trade-off studies to optimize plant operations, and an economic analysis of the plant are included. The plant design provides flow diagrams and equipment specifications for the energy conversion system, the cooling water system, the plant and instrument air system, the flare system, the firewater system, the electrical system, the piping system, instruments and controls, and buildings and structures.

POWER PLANT SYSTEMS AND COMPONENTS

34786 (IDO—1549-8) **Application of direct contact heat exchangers to geothermal power production cycles. Project review, December 1, 1974—May 31, 1977.** Jacobs, H.R.; Boehm, R.F.; Hansen, A.C. (Utah Univ., Salt Lake City (USA)). 1977. Contract EY-76-S-07-1549;EY-76-S-07-1523. 181p. Dep. NTIS, PC A09/MF A01.

Work performed on the development of direct contact heat exchanger power cycles for geothermal applications is reviewed. The period covered in the report is from the inception of the project in 1974 through May 31, 1977. Results from a large experimental program on heat exchanger develpment as well as from many analyses of components and cycle performance and economics are given. A number of working fluids and operating conditions have been considered, and no major obstacles for the implementation of the concept have been discovered.

34787 Geothermal energy processing system with improved heat rejection. Matthews, H.B. (to Sperry Rand Corp.). US Patent 4,059,959. 29 Nov 1977. Filed date 5 Nov 1976. 14p.

The improved geothermal energy extraction system extracts thermal energy stored in hot solute-bearing well water to generate a super-heated fluid from an injected flow of a working fluid. The super-heated fluid is then used to operate a turbine-driven pump at the well bottom for pumping the hot geothermal brine in liquid state toward the earth's surface. After energy for the generation of electrical power is extracted from the brine, a consequently cooled portion of the brine is then used at the earth's surface in a combination unitary cooling tower and working organic fluid condensing system. The invention combines the cooling tower and condenser functions in an integrated unit, the outer surfaces of the condenser tubes being exposed to a cascading flow of cooling brine while the brine is itself being cooled. The condenser tubes are arranged geometrically so that a cleaning device may continuously or upon command travel along the condenser tubes, cleaning their outer surfaces of scale accumulations deposited by the depressurized brine.

GEOTHERMAL ENGINEERING

CORROSION, SCALING, AND MATERIALS DEVELOPMENT

REFER ALSO TO CITATION(S) 34793

34788 (ORNL/TM—6308) **Corrosivity of geothermal brines. Progress report for period ending September 1977. Final report.** Posey, F.A.; Palko, A.A.; Bacarella, A.L. (Oak Ridge National Lab., Tenn. (USA)). Mar 1978. Contract W-7405-ENG-26. 53p. Dep. NTIS, PC A04/MF A01.

Results of studies carried out principally during FY 1976 and FY 1977 on the corrosion of ferrous materials in synthetic geothermal brines are summarized. A survey of prior work on electrochemical aspects of the corrosion of iron and carbon steel in chloride solutions is presented, and some of the results of these investigations are summarized. The principal results of the present studies are then recapitulated. Included are measurements of the corrosion potential, corrosion rate, and polarization behavior of iron and carbon steel in deaerated 4 M NaCl over the pH range from 1 to 11 at temperatures up to 100°C in a conventional Pyrex electrochemical cell. The effect of pH on hydrolysis, precipitation, and electrochemical reactivity of ferrous and ferric ions in 4 M NaCl at 25°C is presented, and implications for plant operation are discussed. Details of a refreshed, stirred titanium autoclave system are described; the system permits electrochemical measurements to be made up to at least 200°in corrosive aqueous saline media. The effect of pH (from pH equals 7 to pH equals 2) and temperature (from 25° to 200°C) on the corrosion rate of type A212B carbon steel in deaerated 4 M NaCl is described. A relatively simple numerical correlation describes the data over the entire temperature and pH range. The spontaneous corrosion potentials and pitting potentials of types 304 and 316 stainless steel were measured in deaerated 4 M NaCl at pH equals 5 from 25° to 200°C, and the data demonstrate the borderline stability of austenitic stainless steel for brine service. Finally, conclusions and recommendations for further studies are presented.

34789 (UCID—16909) **Numerical study of boundary layer injection as a scale control method.** Feiereisen, W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 26 Sep 1975. Contract W-7405-ENG-48. 81p. Dep. NTIS, PC A05/MF A01.

Portions of document are illegible.

A boundary layer injection method of controlling scale-buildup in geothermal two-phase flow nozzles is studied. The object of this study is to set an upper limit on the ratio of the injected mass flow rate to the free stream mass flow rate that is necessary to isolate the scale carrying free stream flow from the nozzle wall. In order to develop a numerical model of the boundary layer flow, assumptions are made which reduce the results to order of magnitude approximations. Two configurations of nozzles with various injection flow rates are tried. It is found by numerical experiment that a nozzle with injection through a 1 mm thick ring near the inlet, is more efficient at isolating the free stream than a porous nozzle. A mass flow rate ratio of 0.173% was necessary to achieve this effect. It may be concluded that an upper limit on the mass flow rate ratio is about 2.0% with injection through a ring near the inlet, and that boundary layer injection is a reasonable method of controlling scale-buildup. A glossary of variables, program documentation and listings are presented for programs GMD15SR8, TRACK11, and TRACK12.

GEOTHERMAL RESERVOIR AND WELL PERFORMANCE

34790 (CONF-770440—, pp 263) **Field test results of the Sperry downwell geothermal pumping system.** McBee, W.; Matthews, H. (Sperry Rand Research Center, Sudbury, MA). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

34791 (LBL—7017) **Recent results from tests on the Republic Geothermal Wells, East Mesa, California.** Narasimhan, T.N.; Schroeder, R.C.; Goranson, C.G.; McEdwards, D.G.; Campbell, D.A.; Barkman, J.H. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Dec 1977. Contract W-7405-ENG-48. 8p. (CONF-771235—1). Dep. NTIS, PC A02/MF A01.

From 3. geothermal workshop; Stanford, CA, USA (14 Dec 1977).

Towards achieving a proper understanding of the resource at East Mesa, well tests were conducted. These included production, injection, and interference tests with durations varying from a few days to several weeks and yielded valuable information on reservoir parameters as well as geometry. Findings from the production-interference tests are summarized. (JGB)

RESERVOIR STIMULATION AND EXTRACTION TECHNOLOGY

REFER ALSO TO CITATION(S) 36135

34792 Method for producing geothermal energy and minerals. Christian, L.D. (to Exxon Production Research Co.). US Patent 4,074,754. 21 Feb 1978. Filed date 27 Sep 1976. 4p.

A method is described for producing geothermal energy and minerals from subteranean high temperature and high salinity water reservoirs by injecting low salinity water at ambient surface temperature into the reservoir through a well bore. The injected water becomes heated in the reservoir and then produces water through the well bore to the surface for use as a source of energy and, optionally, minerals. Simultaneously with the employment of certain wells for injection-production cycles, other wells may be employed predominantly for injection of water to displace heat and in-situ well brines to well bores which produce such water and brines to the surface for utilization of their heat energy and dissolved minerals.

34793 Geothermal power system. Swearingen, J.S. US Patent 4,054,175. 18 Oct 1977. Filed date 12 Dec 1975. 16p.

A system is disclosed for extracting heat from hot unrefined water for the purpose of using this heat to do useful work, and specifically for extracting such heat while minimizing the undesira-

ble effects caused by formation of scale and other solid build-up of scale-forming impurities in the hot unrefined water. Before contact with a heat exchange surface the hot unrefined water has added thereto an agent capable of increasing the formation of non-scale-forming species of said scale-forming impurities. These agents may be added immediately before passing the hot unrefined water through heat exchange equipment and/or directly into a geothermal well.

34794 Growth rate of a penny-shaped crack in hydraulic fracturing of rocks. Abe, H.; Mura, T.; Keer, L.M. (Northwestern Univ., Evanston, IL). *J. Geophys. Res.;* **81**: No. 29, 5335-5340(10 Oct 1976).

The stable growth of a crack created by the hydraulic pressurizing of a penny-shaped crack in a dry rock mass is investigated. The rock mass is infinitely extended, homogeneous, and isotropic. It is verified on the basis of the equations of fluid dynamics that the fracturing fluid cannot penetrate the entire domain of a crack when the crack is moving. The effects of various terms in the basic equations are also studied. The solution of some typical examples is given, and the significant effect of the stress intensity factor of the rock on the crack propagation is shown. When the crack is expanding under a constant flow rate, the classical solution by Sack is found to be approximately valid for very large cracks, and nevertheless the crack is stable.

DIRECT ENERGY UTILIZATION

34795 (PNL—2568) Economic analysis of potential uses of geothermal energy in agriculture. Cone, B.W. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Feb 1978. Contract EY-76-C-06-1830. 78p. Dep. NTIS, PC A05/MF A01.

The economic feasibility and water quality considerations of the cultural practice of soil warming was evaluated using existing technical, agronomic, and economic data. It was hypothesized that it is technically and economically feasible to use geothermal energy in the cultural practice of soil warming for specific crops. The analysis attempted to reject the hypothesis. Since the hypothesis could not be rejected, the results are presented as a profit equation suitable for inclusion in the GEOCOST computer program. This determination of economic feasibility utilized heterogeneous crop yield data by comparing the elasticity of response with a normalized product-factor price ratio. Soil warming was determined to be feasible when the elasticity of production was equal to or greater than the normalized product-factor price ratio. A farm enterprise was determined profitable if net returns were positive. An empirical model in which the energy dissipation rate is a function of the difference between heat source temperature and mean monthly air temperature was transformed to utilize data describing the total heat applied during the growing season. Heat input was then measured as the total number of calories per square centimeter applied during the growing season.

34796 Thermodynamic study of heating with geothermal energy. Reistad, G.M.; Yao, B.; Gunderson, M. (Ore State Univ, Corvallis). *Am. Soc. Mech. Eng., [Pap.];* No. 77-WA/Ener-1, 1-8(1977).

A thermodynamic analysis of various methods of heating while using either purely geothermal energy or a combination of geothermal energy and conventional energy has been completed. Since geothermal energy, unlike conventional fuels, has an available energy that is markedly lower than its energy, a first law of thermodynamics performance parameter cannot accurately portray the thermodynamic performance and the second law based performance parameter (effectiveness) is used as the objective function during optimization. Results of the analysis present the optimum performance of several systems as a function of heating temperature and geothermal resource temperature. These results show that when only heating is required at a temperature substantially below the existing geothermal resource temperature a conventional direct geothermal heating system is thermodynamically desirable. However, when heating is desired at temperatures near that of the geothermal resource, systems that use heat pumps can provide superior performance. 4 refs.

34797 Heat control of a bath tub. II. Temperature of thermal water in bath tub on equilibrational or transitional state. Hosoya, N.; Mashiko, Y. *Onsen Kogakkaishi;* **11**: No. 1, 22-29(1976). (In Japanese).

The relationship between the temperature of bath water and the flux of thermal water supplied are analyzed, and the following equation was obtained on equilibrational state: $T = W.T_1 = k.A.T_0/W + k.T$, where T = temperature (°C) of thermal water in a bath tub; T_1 = temperature (°C) of thermal water supplied; T_0 = room temperature (°C); A = water surface area (m^2); W = flux of thermal water (1/hr); and k = overall coefficient of heat transfer (kcal/m^2 hr°C). After t hour from the beginning of thermal water supply into an empty bath tub, the temperature of bath water is expressed as follows: $T = T.W + k.A.T_0/W + k.A - W.(T_1 - T_0)/W + k.A$ e/sup $^-$(W + k.A)/V.1000. t/, where V = volume of bath tub (m^3); and t = Time (hours).

GEOTHERMAL DATA AND THEORY

REFER ALSO TO CITATION(S) 34769

34798 Rate of crustal extension across the Rio Grande rift near Albuquerque, New Mexico. Woodward, L.A. (Univ. of New Mexico, Albuquerque). *Geology;* **5**: No. 5, 269-272(May 1977).

There has probably been about 8 km of crustal extension in a northwest-southeast direction across the Rio Grande rift near Albuquerque, New Mexico, since approximately 26 m.y. ago, giving an annual rate of about 0.3 mm/yr. This estimate is based on an interpretation that the normal faults bounding the graben decrease in dip downward and extend to a depth of about 10 to 15 km. Below that depth the crust is assumed to have undergone plastic deformation.

PROPERTIES OF AQUEOUS SOLUTIONS

34799 Thermodynamics of seawater at one atmosphere. Millero, F.J.; Leung, W.H. (Univ. of Miami, FL). *Am. J. Sci.;* **276**: No. 9, 1035-1077(Nov 1976).

The solution thermodynamic properties of seawater at 1 atm have been examined over the range of 0° to 40°C and 0 to 40% salinity. By combining the osmotic coefficients [phi = -(55.51/2m) ln a_1, where m is the molality and a_1 is the activity of water] determined from the freezing point measurements of Doherty and Kester (1974), with the heat capacity data of Millero, Perron, and Desnoyers (1973), and the enthalpy data of Millero, Hansen, and Hoff (1973), the osmotic coefficients were determined over the range of 0° to 40°C at 1 atm using the extended Debye-Heuckel equation. The results at 25°C were found to be in excellent agreement with the results of Robinson (1954). From the osmotic coefficient data, the vapor pressure and osmotic pressure have been determined. The osmotic coefficient data at 0°C has been used to calculate the mean activity coefficient and activity of "sea salt." By using the thermodynamic equation delta $\ln a_2$/delta T + - anti L_2/RT, activities have been determined at other temperatures (0° to 40°C). The relative free energies of seawater, $G - G^0 + 55.51\ RT \ln a_1 = m\ RT \ln a_2$, have been calculated from the osmotic and activity data. The relative entropy of seawater ($S - S^0$) was determined from the relative free energies by using the thermodynamic relationship, $S - S^0 + [(G - G^0) - (H - H^0)]/T$, where $H - H^0$ is the relative enthalpy. All the specific thermochemical properties (P) of seawater have been fitted to equations.

34800 Partial molal volume of silicic acid in 0.725 m NaCl. Duedall, I.W. (State Univ. of New York, Stony Brook); Dayal, R.; Willey, J.D. *Geochim. Cosmochim. Acta;* **40**: No. 10, 1185-1189(Oct 1976).

The partial molal volume (anti V) of silicic acid in 0.725 m NaCl at 20 C has been calculated from (1) direct volume changes due to the dissolution of anhydrous sodium silicate and (2) some literature values for the partial molal volumes of NaOH and water. anti V/sub $Si(OH)_4$/, uncorrected for electrostriction effects, was found to be 53 +- 2 ml $mole^{-1}$. anti V/sub $Si(OH)_4$/, corrected for volume changes due to solvent electrostriction by charged Si species, was estimated to be in the range 58-62 ml $mole^{-1}$; this range is 7-11 ml $mole^{-1}$ greater than the anti V/sub $Si(OH)_4$/ calculated from Willey's (Mar. Chem. 2, 239-250, 1974) solubility data obtained from the dissolution, in seawater, of amorphous silica subjected to hydrostatic pressure. The anti V/sub $Si(OH)_4$/ does, however agree within experimental error with the anti V/sub $Si(OH)_4$/ calculated from Jones and Pytkowicz's (Bull. Soc. Roy. Sci. Liege 42, 118-120, 1973) data for the solubility of amorphous silica in seawater at high pressure and is nearly in agreement with Willey's (Ph.D. thesis, Dalhousie University, 1975) solubility data for amorphous silica in 0.6 m NaCl.

34801 Thermodynamics of brine—salt equilibria. II. The system NaCl—KCl—H_2O from 0 to 200°C. Wood, J.R. (Univ. of Wyoming, Laramie). *Geochim. Cosmochim. Acta;* **40**: No. 10, 1211-1220(Oct 1976).

Thermodynamic functions describing salt solubilities and activities in the system NaCl-KCl-H_2O have been obtained over the temperature range 0 to 200°C using existing isopiestic and solubility data. The two-parameter equation used previously at 25°C was sufficient to characterize the activity coefficient of the aqueous binary systems from infinite dilution to saturation, and the mixing behavior could be described by Harned's Rule over this temperature range. Activity coefficients have been calculated for NaCl-KCl-H_2O mixtures as a function of temperature. Calculated solubility curves are in good agreement with the experimental data up to 200°C and estimates of ΔH^0/sub (sat)/ and ΔC^0/sub p(sat)/ calculated from the

first and second temperature derivatives of log K are consistent with measured standard state enthalpies and heat capacities for both NaCl and KCl. The absolute value of the mixing parameters decreases with increasing temperature and approaches zero for both salts in the vicinity of 200°C. The excess free energy of mixing thus approaches zero and may be due to the transition from a dissociated electrolyte solution to one in which associated ions or molecular species are beginning to dominate over 'free' ions. The mixing parameter decreases more rapidly for KCl than for NaCl and suggests that KCl-rich systems become associated at lower temperatures than NaCl-rich systems.

PROPERTIES OF MINERALS AND ROCKS

REFER ALSO TO CITATION(S) 35750, 36144

34802 Comment on the self-consistent imbedding approximation in the theory of elasticity of porous media. Korringa, J.; Thompson, D.D. (Chevron Oil Field Research Co., La Habra, CA). *J. Geophys. Res.;* **82**: No. 5, 933-934(10 Feb 1977).

In calculations of the effective elastic moduli of heterogeneous materials, special care must be taken if one of the components is a liquid. Connections between liquid-filled regions (pores) can lead to a substantial reduction of the moduli. This effect can be incorporated into the computations with use of a theorem due to Gassmann.

ROCK-WATER-GAS INTERACTIONS

34803 (CONF-770440—, pp 250) **Kinetics of silica condensation in brines.** Makrides, A.C.; Turner, M.J.; Slaughter, J.; Harvey, W.W. (EIC Corp., Newton, MA). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

34804 Eksperimental'nye issledovaniya mineraloobrazovaniya v geotermal'nykh skvazhinakh. (Experimental study of mineral formation in geothermal wells). Karpov, G.A. Moscow; Izdatel'stvo Nauka (1976). 172p.

Research on mineral formation in geothermal wells is described. Experiments were conducted in three thermal spring sites on Kamchatka. The metasomatic processes taking place under the influence of the thermal springs are described on the basis of obtained mineral formations and data on the physico-chemical composition of solutions.

WIND ENERGY

AVAILABILITY (CLIMATOLOGY)

34805 (PNL—2508) **Estimates of the number of large amplitude gusts.** Ramsdell, J.V. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Mar 1978. Contract EY-76-C-06-1830. 55p. Dep. NTIS, PC A04/MF A01.

Preliminary estimates are presented of the number of occurrences of large amplitude gusts for use in the design of wind energy conversion systems. Existing turbulence information has been combined with an assumed wind speed distribution to arrive at the estimates. The number of large amplitude gusts per year is treated as a function of the annual mean wind speed and terrain roughness. This treatment is based upon the assumptions that the atmosphere has neutral stability during high winds and that the gustiness is induced by flow over surface roughness elements. Large gusts during thunderstorms and other severe weather phenomena are not treated. The results of the study are presented in tabular form as a function of gust amplitude and hourly average wind speed.

ECONOMICS

34806 Low efficiency of wind power. Hannervall, L.; von Zweygbergk, S. (Statens Vattenfallsverk, Swed). *Tek. Tidskr.;* **107**: No. 13, 27-28, 32-33(9 Sep 1977). (In Swedish).

Experimental small-scale wind power plants in Sweden are described and their operational experience is evaluated. The data obtained give no reason to an exaggerated optimism as to the wind power plant efficiency; the installation costs are high and the energy production is low. Probabilities for an economical energy production with small-scale wind power plants are shown to be small.

WIND ENERGY ENGINEERING

REFER ALSO TO CITATION(S) 34732

APPLICATIONS

34807 (SAN—1101-76/2) **Wind machines for the California Aqueduct. Volume II. Final report. Aerospace report No. ATR-76(7536-01)-1 Vol. II.** Lindley, C.A. (Aerospace Corp., El Segundo, Calif. (USA). Energy and Transportation Div.). Mar 1977. Contract EY-76-C-03-1101-005. 204p. Dep. NTIS, PC A10/MF A01.

A study was made of the feasibility of using wind machines to provide part of the energy required to pump water in the California Aqueduct. The need for additional pumping power for the Aqueduct will be especially felt in 1983 when existing arrangements which assure deliveries of low-cost energy from four California utilities terminate. The development and production schedule for the ERDA/NASA 1500 kW wind machine design as now understood could support the installation of a wind energy system to meet a significant portion of the Aqueduct needs by that date if few delays are encountered. This application of wind energy was found to be technically feasible, but would involve some operational problems. The Aqueduct application may be attractive for an early wind energy pilot or demonstration project because of the near-term ability of the Aqueduct to adapt its demand to the variability of the wind.

TURBINE DESIGN AND OPERATION

34808 (CONF-771148—) **Wind turbine structural dynamics.** (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). 1978. 290p. Dep. NTIS, PC A13/MF A01.

From Wind turbine structural dynamics conference; Cleveland, OH, USA (15 Nov 1977).

Separate abstracts are included for each of the 26 papers presented concerning the design and performance of wind turbines.

34809 (CONF-771148—, pp 1-13) **Comparison of computer codes for calculating dynamic loads in wind turbines.** Spera, D.A. (Lewis Research Center, Cleveland). 1978.

From Wind turbine structural dynamics conference; Cleveland, OH, USA (15 Nov 1977).

In Wind turbine structural dynamics.

The development of at least seven codes by NASA and its contractors is described. As might be expected in an area of new technology, these codes differ considerably in approach and technique. Because of the generally complicated nature of any structural dynamics analysis, a detailed comparison of seven computer codes is extremely difficult. Therefore, the objectives of this study have been limited to the following: to present a brief overview of each code and identify sources for further datailed information, and to compare the performance of each code against two sets of test data measured on the 100 kW Mod-0 wind turbine, an experimental machine in operation at NASA's Plum Brook Station near Sandusky, Ohio. Comparison on the basis of cyclic loads, peak loads, and harmonic contents was selected.

34810 (CONF-771148—, pp 15-29) **MOD-1 WTG dynamic analysis.** Stahle, C.V. Jr. (General Electric Co., Valley Forge, PA). 1978.

From Wind turbine structural dynamics conference; Cleveland, OH, USA (15 Nov 1977).

In Wind turbine structural dynamics.

The dynamic analysis is presented of the MOD-1 2000 KW horizontal-axis wind turbine. After briefly describing the MOD-1 design, the dynamic analysis used to evaluate the dynamic loads and structural interactions is discussed. The resonant frequency placement, the treatment of unsteady wind loading and the dynamic load sensitivity to frequency shifts are reviewed for the design.

34811 (CONF-771148—, pp 31-37) **Simplified modeling for wind turbine modal analysis using nastran.** Sullivan, T.L. (Lewis Research Center, Cleveland). 1978.

From Wind turbine structural dynamics conference; Cleveland, OH, USA (15 Nov 1977).

In Wind turbine structural dynamics.

A simplified finite element model of the Mod-0 wind turbine tower is described. Use of this model greatly reduces the computer time required for modal analysis. The model provides good accuracy in predicting tower frequencies and mode shapes as long as the tower bending mode shape resembles the first bending mode shape of a cantilever beam. Several applications where the simplified model was used for modal analysis are described.

34812 (CONF-771148—, pp 39-52) **Use of asymptotic methods in vibration analysis.** Ashley, H. (Stanford Univ., CA). 1978.

From Wind turbine structural dynamics conference; Cleveland, OH, USA (15 Nov 1977).

In Wind turbine structural dynamics.

Two subjects are discussed, which are believed relevant to the structural analysis of vertical-axis wind turbines. The first involves the derivation of dynamic differential equations, suitable for studying the vibrations of rotating, curved, slender structures. The Hamiltonian procedure is advocated for this purpose. Various reductions of the full system are displayed, which govern the vibrating Troposkien when various order-of-magnitude restrictions are placed on important parameters. The final section discusses the possible advantages of the WKB asymptotic method for solving these classes of problems. A special case of this method is used illustratively to calculate eigenvalues and eigenfunctions for a "flat" turbine blade with small flexural stiffness.

34813 (CONF-771148—, pp 53-60) **Aeroelastic analysis of wind energy conversion systems.** Dugundji, J. (Massachusetts Inst. of Tech., Cambridge). 1978.

From Wind turbine structural dynamics conference; Cleveland, OH, USA (15 Nov 1977).

In Wind turbine structural dynamics.

An aeroelastic investigation of horizontal axis wind turbines is described. The study is divided into two simpler areas, namely, the aeroelastic stability of a single blade on a rigid tower, and the mechanical vibrations of the rotor system on a flexible tower. Some resulting instabilities and forced vibration behavior are described.

34814 (CONF-771148—, pp 61-69) **Aeroelastic stability of wind turbine blades.** Kaza, K.R.V. (Univ. of Toledo). 1978.

From Wind turbine structural dynamics conference; Cleveland, OH, USA (15 Nov 1977).

In Wind turbine structural dynamics.

The second-degree nonlinear aeroelastic equations for a flexible, twisted, non-uniform wind turbine blade are developed using Hamilton's principle. The derivation of these equations has its basis in the geometric nonlinear theory of elasticity. These equations with periodic coefficients are suitable for determining the aeroelastic stability and response of large wind turbine blades. Methods for solving these equations are discussed.

34815 (CONF-771148—, pp 71-76) **Flow field analysis.** Cliff, W.C.; Verholek, M.G. (Battelle Pacific Northwest Labs., Richland, WA). 1978.

From Wind turbine structural dynamics conference; Cleveland, OH, USA (15 Nov 1977).

In Wind turbine structural dynamics.

The average mean wind speed integrated over a disk is shown to be extremely close to the mean value of wind speed which would be measured at the center of a disk for most geometries in which a WECS (Wind Energy Conversion System) would operate. Field test results are presented which compare instantaneous records of wind speed integrated over a disk with the wind speed measured at the center of the disk. The wind field that a rotating element would experience is presented which has been synthesized from the outputs of an array of anemometers.

34816 (CONF-771148—, pp 77-93) **Flutter of Darrieus wind turbine blades.** Ham, N.D. (Massachusetts Inst. of Tech., Cambridge). 1978.

From Wind turbine structural dynamics conference; Cleveland, OH, USA (15 Nov 1977).

In Wind turbine structural dynamics.

The testing of Darrieus wind turbines has indicated that under certain conditions, serious vibrations of the blades can occur, involving flatwise bending, torsion, and chordwise bending. A theoretical method of predicting the aeroelastic stability of the coupled bending and torsional motion of such blades is presented with a view to determining the cause of these vibrations and a means of suppressing them.

34817 (CONF-771148—, pp 95-101) **Analytical testing techniques.** Jones, R. (Kaman Aerospace Corp., Bloomfield, CT). 1978.

From Wind turbine structural dynamics conference; Cleveland, OH, USA (15 Nov 1977).

In Wind turbine structural dynamics.

Structural Dynamic Analytical Testing Techniques can be a tool to determine the source of structural dynamic problems and the solution to these problems. Analytical testing techniques are based upon new and unique dynamic testing methods and analysis of test results. Thus, these methods apply primarily to constructed wind turbine systems. This paper gives a summary of these methods.

34818 (CONF-771148—, pp 103-108) **Influence of wind turbine foundation.** Yee, S.T. (Lewis Research Center, Cleveland). 1978.

From Wind turbine structural dynamics conference; Cleveland, OH, USA (15 Nov 1977).

In Wind turbine structural dynamics.

The 200 kW Mod-0A wind turbine was modeled using a 3 lumped mass-spring system for the superstructure and a rotational spring for the foundation and supporting soil. Natural frequencies were calculated using soil elastic moduli varying from 3000 to 22,400 p.s.i. The reduction in natural frequencies from the rigid foundation case ranged up to 20 percent.

34819 (CONF-771148—, pp 109-116) **Summary of static load test of the MOD-0 blade.** Miller, D.R. (Lewis Research Center, Cleveland). 1978.

From Wind turbine structural dynamics conference; Cleveland, OH, USA (15 Nov 1977).

In Wind turbine structural dynamics.

A static load test was performed on the spare Mod-0 windturbine blade to define load transfer at the root end of the blade, and to validate stress analysis of this particular type of blade construction (frame and stringer). Analysis of the load transfer from the airfoil skin to the shank tube predicted a step change in spanwise stress in the airfoil skin at station 81.5 inches (STA 81.5). For flatwise bending a 40% reduction in spanwise stress was predicted, and for edgewise bending a 6% reduction. Experimental results verified the 40% reduction for flatwise bending, but indicated about a 30% reduction for edgewise bending.

34820 (CONF-771148—, pp 117-150) **DOE/NASA MOD-0 100 kW wind turbine: test results.** Glasgow, J.C. (Lewis Research Center, Cleveland). 1978.

From Wind turbine structural dynamics conference; Cleveland, OH, USA (15 Nov 1977).

In Wind turbine structural dynamics.

The Mod-0 100kW Wind Turbine was designed and fabricated by the NASA under the direction of the U.S. Department of Energy to assess technology requirements and engineering problems of large wind turbines. Data which is associated with rotor and machine dynamics problems encountered and the machine modifications incorporated as a solution are presented. These include high blade loads due to tower shadow, excessive nacelle yawing motion, and power oscillations. The results of efforts to correlate measured wind velocity with power output and wind turbine loads are also discussed.

34821 (CONF-771148—, pp 167-178) **MOD-1 wind turbine generator analysis.** Barton, R.S. (General Electric Co., Philadelphia). 1978.

From Wind turbine structural dynamics conference; Cleveland, OH, USA (15 Nov 1977).

In Wind turbine structural dynamics.

A general summary of the MOD-1 Wind Turbine Generator control system and simulation is presented. Mechanical and speed stabilization control means to add drive train damping are mentioned and MOD-1 simulation results showing the effects of speed stabilization are displayed.

34822 (CONF-771148—, pp 195-218) **Some alternative dynamic design configurations for large horizontal axis WECS.** Hohenemser, K.H. (Washington Univ., St. Louis). 1978.

From Wind turbine structural dynamics conference; Cleveland, OH, USA (15 Nov 1977).

In Wind turbine structural dynamics.

The present U.S. development effort toward large horizontal axis WECS concentrates on the configuration with two rigid blades with collective pitch variation and a yaw gear drive. Alternative configurations without yaw gear drive are considered where the rotor is either self-centering or where the yaw angle is controlled by blade cyclic pitch inputs. A preliminary evaluation of the dynamic characteristics for these alternative design configurations is presented.

34823 (CONF-771148—, pp 219-225) **Fatigue load spectra for upwind and downwind rotors.** Andrews, J.S. (Boeing Engineering and Construction, Seattle). 1978.

From Wind turbine structural dynamics conference; Cleveland, OH, USA (15 Nov 1977).

In Wind turbine structural dynamics.

Effect of both alternating and mean load on the fatigue life of an upwind and downwind MOD-2 wind turbine system is presented. It was shown that the fatigue damage varies as the product of the stress range cubed and the maximum stress. Hence, the alternating flapwise load caused by tower shadow and wind gradient is an important factor in determining rotor blade life.

34824 (CONF-771148—, pp 227-236) **Effects of rotor location, coning, and tilt on critical loads in large wind turbines.** Spera, D.A.; Janetzke, D.C. (Lewis Research Center, Cleveland). 1978.

From Wind turbine structural dynamics conference; Cleveland, OH, USA (15 Nov 1977).

In Wind turbine structural dynamics.

Three large (1500 kW) horizontal rotor configurations were analyzed to determine the effects on dynamic loads of upward and downwind rotor locations, coned and radial blade positions, and tilted and horizontal rotor axis positions. Loads were calculated for a

range of wind velocities at three locations in the structure: the blade shank, the hub shaft, and the yaw drive. Blade axis coning and rotor axis tilt were found to have minor effects on loads. However, locating the rotor upwind of the tower significantly reduced loads at all locations analyzed.

34825 (CONF-771148—, pp 237-242) **Comparison of blade loads of fixer and free yawing wind turbines.** Cheney, M.C.; Bielawa, R.L. (United Technologies Research Center, East Hartford, CT). 1978.

From Wind turbine structural dynamics conference; Cleveland, OH, USA (15 Nov 1977).

In Wind turbine structural dynamics.

The UTRC Self Regulating Composite Bearingless Wind Turbine utilizes an automatic pitch control concept and a completely unrestrained yawing degree of freedom. Aerodynamic moments caused by skewed flow provide the control to align the wind turbine with the wind. Model tests have demonstratd the feasibility of the concept and analytical studies have shown the free system to experience lower blade loads compared to the fixed system.

34826 (CONF-771148—, pp 243-254) **Fixed pitch wind turbines.** Fenn, D.B.; Viterna, L.A. (Lewis Research Center, Cleveland). 1978.

From Wind turbine structural dynamics conference; Cleveland, OH, USA (15 Nov 1977).

In Wind turbine structural dynamics.

Wind turbines designed for fixed pitch operation offer potential reductions in the cost of the machine by eliminating many costly components. Studies have shown that a rotor can be designed which produces the same energy annually as Mod-O but which regulates its power automatically by progressively stalling the blades as wind speed increases. Effects of blade twist, taper, root cutout, and airfoil shape on performance are discussed. Unfortunately, fixed pitch rotors are not self-starting when the pitch is set to maximize energy production per year. Various starting techniques are discussed.

34827 (CONF-771148—, pp 257-260) **Research of low cost wind generator rotors.** Fertis, D.G. (Univ. of Akron, OH); Ross, R.S. 1978.

From Wind turbine structural dynamics conference; Cleveland, OH, USA (15 Nov 1977).

In Wind turbine structural dynamics.

This feasibility program determined that it would be possible to significantly reduce the cost of manufacturing wind generator rotors by making them of cast urethane. Goodyear developed several high modulus urethanes which were structurally tested at the University of Akron. A section of rotor was also cast and tested showing the excellent aerodynamic surface which results. A design analysis indicated that a cost reduction of almost ten to one can be achieved with a small weight increase to achieve the same structural integrity as expected of current rotor systems.

34828 (CONF-771148—, pp 261-264) **Plans for wind energy system simulation.** Dreier, M.E. (Paragon Pacific, Inc., El Segundo, CA). 1978.

From Wind turbine structural dynamics conference; Cleveland, OH, USA (15 Nov 1977).

In Wind turbine structural dynamics.

Two new analysis tools, one a digital computer code and the other a special purpose hybrid computer, are introduced. The digital computer program, the Root Perturbation Method or RPM, is a new implementation of the classic Floquet procedure which circumvents numerical problems associated with the extraction of Floquet roots. The hybrid computer, the Wind Energy System Time-domain simulator (WEST), yields real-time loads and deformation information essential to design and system stability investigations.

34829 (CONF-771148—, pp 265-268) **UMass wind furnace blade design.** Cromack, D.E. (Univ. of Massachusetts, Amherst). 1978.

From Wind turbine structural dynamics conference; Cleveland, OH, USA (15 Nov 1977).

In Wind turbine structural dynamics.

A brief description of the UMass Wind Furnace concept is presented along with some preliminary performance data. Particular emphasis is placed on the design, construction, and manufacturing procedure for the 32.5 foot diameter GRP blades.

34830 (CONF-771148—, pp 275-283) **Brush wind turbine generator as described in Scientific American of December 20, 1890.** Spera, D.A. (Lewis Research Center, Cleveland). 1978.

From Wind turbine structural dynamics conference; Cleveland, OH, USA (15 Nov 1977).

In Wind turbine structural dynamics.

An historic wind turbine generator is described which operated in Cleveland, Ohio, from 1888 to 1908. The machine had a 144-blade rotor 56 feet in diameter, a pivoted tower 60 feet high, and a maximum output of 12 kW DC. The description is based on an 1890 article in Scientific American journal.

34831 (COO—2617-4/1) **Giromill wind tunnel test and analysis. Volume I. Executive summary. Final report, June 1976—October 1977.** Moran, W.A. (McDonnell Aircraft Co., St. Louis, Mo. (USA)). Oct 1977. Contract EY-76-C-02-2617. 20p. Dep. NTIS, PC A02/MF A01.

The study described herein is a continuation of the Giromill investigation in which a wind tunnel test of a model Giromill rotor was performed. The primary objective of the wind tunnel test was to obtain data for comparison with the Larsen cyclogiro vortex theory program employed for predicting the Giromill performance. The model had a rotor diameter of 7 ft. (2.13 meters) and a solidity (total blade area divided by rotor span times diameter) of 0.3. This was achieved by a three bladed rotor having blade chords of 8.4 in. (21.3 cm) and a span of 5 ft. (1.52 meters). The blades were modulated by use of replaceable cams, that simulated the various operating conditions, and a push rod arrangement connected to a bellcrank about the blade pivot point. Rotor RPM control was achieved with an electric motor/generator that could be used to either drive the rotor or absorb the rotor power to maintain RPM.

34832 (SAND—77-1375) **Performance evaluation of wind energy conversion systems using the method of bins: current status.** Akins, R.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). Mar 1978. Contract EY-76-C-04-0789. 21p. Dep. NTIS, PC A02/MF A01.

A detailed description of the method of bins, a technique of data collection and reduction for field performance evaluation of Wind Energy Conversion Systems (WECS) is provided. The method of bins is a straightforward yet useful approach to the complex problem of relating the response of a WECS to a variable wind field. Examples of typical results obtained using the method of bins are presented. Methods of determining that the measure of performance of a WECS obtained is correct are outlined. Areas in which further modifications to the technique may be appropriate are also discussed.

34833 (TID—27885) **Vortex augmentors for wind energy conversion. Progress report, May—November 1976.** Sforza, P.M. (Polytechnic Inst. of New York, Farmingdale (USA). Aerodynamics Labs.). Dec 1976. Contract EX-76-S-01-2358. 119p. Dep. NTIS, PC A06/MF A01.

A progress report on advanced research, design, and development on aerodynamic devices which can concentrate and augment natural winds is presented. The keystone element here is the generation and control of discrete vortices of high kinetic energy density by the appropriate interaction of suitably designed aerodynamic surfaces with natural winds of low kinetic energy density. There are four major tasks in the present programs which are discussed: performance monitoring and control; design, analysis, and development; systems and economic aspects; and field testing.

34834 **Lifting foils: tap energy of flowing air or water.** Kocivar, B. *Pop. Sci.;* **212**: No. 2, 71-73, 168(Feb 1978).

Extracting power from flow water or surface wind is accomplished by using a series of interconnected foils. Different configurations and applications are discussed.

34835 **Shrouded aerogenerator.** Igra, O. (Univ. of the Negev, Beersheva, Israel). *Energy (Oxford);* **2**: No. 4, 429-439(Dec 1977).

Experimental studies have been performed on a shrouded aerogenerator. The device tested will produce about twice the output power obtainable from an ideal wind turbine working under the same freestream conditions but without a duct. The aerogenerator does not require a driving mechanism that will keep it parallel to the free-stream direction. A simple, two-stage turbine with fixed blade geometry will provide the expected power output over a fairly wide range of free-stream velocities and rotational speeds.

POWER CONVERSION SYSTEMS

REFER ALSO TO CITATION(S) 35329

34836 (CONF-771148—, pp 151-156) **Power oscillation of the MOD-0 wind turbine.** Seidel, R.C. (Lewis Research Center, Cleveland). 1978.

From Wind turbine structural dynamics conference; Cleveland, OH, USA (15 Nov 1977).

In Wind turbine structural dynamics.

The Mod-0 power has noise components with varying frequency patterns. Magnitudes reach more than forty percent power at the frequency of twice per rotor revolution. Analysis of a simple torsional model of the power train predicts less than half the observed magnitude and does not explain the shifting frequencies of the noise patterns.

34837 (CONF-771148—, pp 157-166) **Drive train dynamic analysis.** Giansante, N. (Kaman Aerospace Corp., Bloomfield, CT). 1978.

From Wind turbine structural dynamics conference; Cleveland, OH, USA (15 Nov 1977).

In Wind turbine structural dynamics.

A method for parametric variations in drive train dynamic analysis is described. The method models the individual components of a drive system, forms the appropriate system interface coordinates and calculates the system dynamic response at particular frequencies. Application of the method for prediction of the dynamic response characteristics of a helicopter transmission and a comparison of results with test data is also included.

34838 (CONF-771148—, pp 179-186) **Methods of attenuating wind turbine ac generator output variations.** Gold, H. (Lewis Research Center, Cleveland). 1978.

From Wind turbine structural dynamics conference; Cleveland, OH, USA (15 Nov 1977).

In Wind turbine structural dynamics.

Wind speed variation, tower blockage and structural and inertial factors produce unsteady torque in wind turbines. Methods for modifying the turbine torque so that steady torque is delivered to the coupled AC generator are discussed. The method that may evolve will be influenced by the power use that develops and the trade-offs of cost, weight and complexity.

34839 (CONF-771148—, pp 187-193) **Dynamics of drive systems for wind energy conversion.** Martinez-Sanchez, M. (Massachusetts Inst. of Tech., Cambridge). 1978.

From Wind turbine structural dynamics conference; Cleveland, OH, USA (15 Nov 1977).

In Wind turbine structural dynamics.

Calculations are performed to determine the dynamic effects of mechanical power transmission from the nacelle of a horizontal axis wind machine to the ground or to an intermediate level. It is found that resonances are likely at 2 or 4/REV, but they occur at low power only, and seem easily correctable. Large reductions are found in the harmonic torque inputs to the generator at powers near rated.

SITE CHARACTERISTICS

34840 (RLO—2342-77/2) **Stochastic modelling of site wind characteristics. Final report.** Corotis, R.B. (Northwestern Univ., Evanston, Ill. (USA). Dept. of Civil Engineering). Sep 1977. Contract EY-76-S-06-2342. 155p. Dep. NTIS, PC A08/MF A01.

Statistical analysis procedures and probability models that are applicable to wind energy conversion sites in general are developed. Special computer algorithms are used to study variances, fit probability distributions, analyze run duration, and determine correlation structure in the wind. A total of 20 one-hour or three-hour records are analyzed from sites in New England, Illinois, Montana, Kansas, Wyoming, and Texas in developing and testing the models.

ELECTRIC POWER ENGINEERING

POWER PLANTS AND POWER GENERATION

REFER ALSO TO CITATION(S) 34711, 34949, 35796

34841 (FE—2291-11) **High temperature turbine technology program. Phase I. Topical report: technology development plan for Phase II.** (Curtiss-Wright Corp., Wood-Ridge, N.J. (USA). Power Systems Div.). Feb 1977. Contract EX-76-C-01-2291. 124p. (CW-WR—76-020.11). Dep. NTIS, PC A06/MF A01.

The ERDA High Temperature Turbine Technology Program has recognized that the most attractive system for using low BTU, coal-derived fuel gas and coal-derived liquid fuel is the combined cycle power plant. It also recognizes that gasification and liquefaction costs can be offset by increasing the gas-turbine efficiency through operation at higher turbine inlet temperatures. The overall objective of this program is to develop a high temperature turbine sub-system, for an open-cycle industrial gas turbine, which meets the following goals: Operation at 2600°F to 3000°F turbine inlet gas temperatures; utilization of low BTU gasified coal and coal-derived liquid fuels; and suitability for integration into a high efficiency, combined-cycle electric power generating plant. In Phase I selection of the turbine cooling concept and design definition of the high temperature turbine sub-system were established. The Phase II Technology Development Program is centered around performance and durability oriented rig and engine testing on utility size turbine sub-system components, and includes supporting design, materials, fabrication and analytical studies. It is designed to provide early assurance of both the feasibility and endurance of high temperature turbine cooling concepts for operation on coal-derived fuels. The primary turbine sub-system concept to be evaluated during Phase II is transpiration air cooling for both the turbine rotor and stator. The back-up turbine sub-system is a transpiration steam cooled rotor and a closed-loop, convection steam cooled stator. The combustor design to be utilized for both liquid and gaseous fuel rig testing will be a film-cooled annular design.

34842 **Contribution to the technical-economical optimization of thermoelectric power plants.** Troilo, M. (Univ di Genova, Italy). *Termotecnica (Milan);* **31**: No. 9, 442-452(Sep 1977).

Considering the minimum energy cost criterion, a simplified analysis for steam power plants is developed, which allows one to write down the energy cost in function of the main variables describing the thermodynamic cycle and the steam boiler operation. The minimum energy cost conditions are then evaluated through the use of a computer program, giving also their dependence upon the relative variations of capital and fuel costs. In particular the conditions of maximum thermodynamic efficiency and of minimum cost are presented for reheating plants, making direct use of the best available correlations for the properties of steam. Then reference is made to an actual case, and the feasible evolution of an existing plant towards improved arrangements is studied. These arrangements allow some savings, leaving unchanged the fundamental characteristics of the original plant. In conclusion, the technical and economical problems arising from the suggested improvements are discussed.

34843 **Ways to further improvement of the efficiency of automated control of power units.** Mironov, V.D.; Stefani, E.P.; Rinkus, E.K.; Safronnikov, S.A.; Dement'ev, V.A. (All-Union Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 8, 2-3(Aug 1977). (In Russian).

The present state of the efficiency of control of power units and of the optimization of their control, relying on the economic criterion, is considered.

34844 **Change of efficiency of a 300 MW power unit during its operation in the regulating mode.** Makarch'yan, V.A.; Fotin, L.P. (All-Union Sci Res Inst of Electr Power Eng, USSR). *Teploenergetika (Moscow);* No. 8, 13-18(Aug 1977). (In Russian).

Experimental data are obtained for an evaluation of changes of the efficiency of a 300 MW power unit fired by residual fuel oil, following its switchover to the regulating mode of operation. These data are confronted with an appropriate evaluation for a 200 MW unit fired by gas, and with an evaluation for a 300 MW unit, obtained by the method of calculation of the technical and economic efficiency of the automation systems of thermal power plants.

34845 **Failures of the RP2 control instrument and their outward manifestations.** Yakovlev, Yu.S. (Chuvash State Univ, USSR). *Teploenergetika (Moscow);* No. 8, 91(Aug 1977). (In Russian).

An investigation is made into the types of failures of the automatic controllers RP2 used at steam power plants and of the outward manifestations of these failures. During an experimental investigation the failures of all the elements and circuits of the control instrument are simulated, except those whose reliability is undoubted. The results are presented in a table and can be used in calculating the reliability of real control systems.

34846 **Comparative study of reactor kinetics solution methods.** Charagi, S.K.; Thangasamy, S. (Bhabha Atomic Research Centre, Bombay (India). Reactor Control Div.). pp 205-219 of Proceedings of the symposium on power plant dynamics and control [held at Bombay during] February 23-24, 1976. Bombay; Department of Atomic Energy (1976).

From Symposium on power plant dynamics and control; Bombay, India (23 Feb 1976).

See CONF-760265—.

One of the important aspects of reactor control is an understanding of power transients, which arise due to reactivity perturbations. These reactivity perturbations can be due to various reasons e.g. due to temperature, change in location of reflector, absorber etc. Quite often point kinetic equations are used in the study of these power transients. These point kinetic equations being non-linear are solved by various numerical methods. For few simple reactivity perturbations, analytical solutions of these equations are possible. Various numerical methods (for accuracy and efficiency) used in solution of these point kinetic equations are compared. Two types of reactivity perturbations have been considered i.e. step and ramp reactivity changes. FORTRAN programs developed following the methods of analytical continuation, Runge-Kutta, linear approximation (i.e. RE-29). Kagannove parabolic approximation, Keepin's integral equation method, Hansen's exponential approximation method and Pade's approximations.

34847 **Universal criteron for optimising versions of heat supply from heat and power stations.** Korneichev, A.I.; Dmitriev, I.V.; Fridman, M.O. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 4, 38-41(1976).

Translated from Teploenergetika; 23: No. 4, 61-64(1976).

In the engineering and economic optimization of a heat and power station using the method of completing expenditures on electric power, as with use of conventional methods of comparison, a universal criterion of estimation is the difference between design

expenditures for the appropriate version of the station and the expenditures on power supply in a separate system equivalent to this version. An equation is given to determine the expenditure on power supply in the separate system. If the station is characterized by different thermal loads, then, in the equivalent separate system, one should make allowance for full expenditures on energy supply. The proposed criterion can be used both in automation of the calculation process and in manual calculations. The use of this criterion in developing algorithms of engineering and economic calculations, using electronic computers, simplifies the algorithm and reduces the volume of programs and machine time.

34848 Investigations of the processes of phase conversions and of the mechanics of two-phase flows. Labuntsov, D.A. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 6, 1-3(1976).

Translated from Teploenergetika; 23: No. 6, 2-4(1976).

Processes of steam generation, of boiling, condensation, and motion of steam/liquid flows determine the efficiency of thermal power equipment and efficiency of power cycles of thermal power stations. The Soviet Union over a period of several decades has carried out extensive investigations in this field. Effective methods of analysis and of generalization of experimental data, based on similarity theory, have been developed, and numerous experimental investigations of the main working heat-engineering processes carried out. The methods of complete and appropriate simulation of thermal and hydrodynamic processes have been successfully developed and introduced in engineering practice. Fundamental results were obtained by investigating the mechanisms and the laws of the processes of condensation of steam and of boiling of liquids. The investigations of critical heat fluxes with boiling of liquid under conditions of free motion were of great importance. The hydrodynamic theory of critical heat fluxes was first formulated in the USSR. This theory made it possible quantitatively to describe the laws of these complex processes. Much attention was paid to the hydromechanics of steam/water flows.

34849 Some recommendations on construction of a model of a generating unit inserted into a simulator. Klushin, Yu.A.; Barykova, N.G.; Gribanova, Z.K.; Zisman, A.S. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 6, 36-38(1976).

Translated from Teploenergetika; 23: No. 6, 41-43(1976).

It is necessary to reproduce on the simulator of a generating unit the stages of the highest intensity as well as the stages which are most important although their intensity mayay be not maximal. Preparatory stages of work for individual systems at the stage when they are still not connected by the common process flow diagram should not be simulated at all or should be simulated in very simplified form. Operators can be taught the simple production procedures required for preparatory stages without using a simulator and the knowledge obtained can easily be consolidated and improved on equipment put out of operation for maintenance. The above recommendations became obvious after construction of the network graph. Owing to the clarity of the network graph it can be recommended for workers of power stations as a visual aid for operators of unit control panels over a period of startup. Then contingent deviations of the actual path from the critical in the prestarting and starting periods can be easily evaluated and recorded for subsequent analysis and optimization of the algorithm of starting operations.

34850 Loss of pressure in a pipe with discharge of critical two-phase flow from it. Fisenko, V.V.; Sychikov, V.I. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 8, 75-77(1976).

Translated from Teploenergetika; 23: No. 8, 83-84(1976).

The determination of critical discharge of two-phase mixture is required in solving the problem of ensuring safety and reliability of power plants. In the general case of motion in pipes of two-phase mixture of high moisture content, especially with critical discharge of it, along with viscosity it is necessary to take into account the influence of compressibility. In the latter case its influence may be found to be determining. At the same time the hydrodynamics of flow of medium in a channel is determined by the velocity of propagation of sound, close to thermodynamic equilibrium velocity.

COOLING AND HEAT TRANSFER EQUIPMENT AND SYSTEMS

REFER ALSO TO CITATION(S) 35156, 35932

34851 Cooling tower supporting columns and reinforcing rings in small and large displacement analyses. Chan, A.S.L. (Imperial Coll. of Science and Tech., London); Wolf, J.P. *Comput. Methods Appl. Mech. Eng.;* **13**: No. 1, 1-26(Jan 1978).

The basic elastic and geometric stiffness properties of the individual supporting columns are synthesized into a stiffness matrix compatible with an axisymmetrical shell element by a series of transformations, to be used in conjunction with a finite element representation of the cooling tower, where the displacements are decomposed into Fourier harmonics. Thus, the effect of the column supports can be rigorously accounted for in a large displacement nonlinear analysis. To complete the stiffness property of the cooling tower structure, the elastic and geometric stiffness of the reinforcing rings are also incorporated. Examples are given to show the effect of these additions on the buckling wind load and the stress distribution.

34852 Development of automatic control systems for feedwater treatment at steam power plants. Zhivilova, L.M.; Goratskii, B.S.; Nazarenko, P.N. (All-Union Heat Eng Inst-Tulenergo, USSR). *Teploenergetika (Moscow);* No. 7, 58-63(Jul 1977). (In Russian).

Problems of rational combination of different types of analyzers in automatic control systems are considered on the basis of the available experience. Ways of further development of such systems are mapped out, taking into consideration the advantages obtained and the expenditure for the installation and maintenance of the instruments involved. 16 refs.

34853 Commissioning and initial operating results of the Nora sodium hypochlorite production cell at the Havre Power Plant. Guyader, H. (Electr de Fr). *Rev. Gen. Electr.;* **86**: No. 7/8, 611-622(1977). (In French).

Having first recalled the data of the problem, i.e., proliferation of marine organisms in the cooling circuits of sea-water cooled power stations, the article considers the processes now in use to fight the fixing of these organisms and, in particular, the one applied from 1974 to the Havre power station, based on Nora sodium hypochlorite. The different problems arising from sea-water loops, the means used in fighting the proliferation of fauna and flora which offer full guarantee on environmental safety are considered and conclusions of the experience thus acquired are given. The operating principle, the equipment used and the main steps of the erection of the plant are described in the next chapters. The operating results, the observations made during plant maintenance and the main corresponding final adjustments which have been made are then discussed. The conclusion is devoted to the extension of the experience acquired at the Havre plant to future nuclear power stations situated on seashore and, in particular, to that of Gravelines.

POWER CYCLES

REFER ALSO TO CITATION(S) 34912

34854 (TID—28257) **Single wheel gas turbine topping unit for coal burning power plants. Final report.** Jackson, T.W.; Colwell, G.T. (Georgia Inst. of Tech., Atlanta (USA). School of Mechanical Engineering). Jun 1976. Contract EY-76-S-05-4959. 138p. Dep. NTIS, PC A07/MF A01.

One-dimensional mathematical models were developed which approximate flow behavior in a viscous turbine and a viscous compressor. The models were validated by comparison with available experimental data for the viscous compressor and by comparison with limiting cases where the solutions are known. Detailed performance characteristics, including efficiency, pressure ratio, and shaft horsepower, of both turbine and compressor were generated. Potential use of a viscous topping turbine for application in fossil fuel power plants was studied. Unit operation with single and multiple wheel staged turbines was evaluated for efficiency and net output in shaft horsepower. The effects of varying flow area, heat transfer, and supersonic flow were studied. Results of varied turbine and compressor parameters are displayed in graphical fashion. The concept was evaluated and the results indicate a possibility of providing a more efficient system to derive electrical energy from fossil fuel. Recommendations for further study are included.

34855 Using simulation for the combined gas/steam turboset of the Lausward power plant. Wilhelm, H.; Goelz, M. *BBC-Nachr.;* **59**: No. 11, 458-465(1977). (In German).

In combined gas/steam power stations, the exhaust gases of the gas turbine serve as combustion air for the steam generator. In order to have full command over the extremely complex closed-loop control system in the planning stage, BBC have simulated the gas/steam process on the modular simulation system MOSIM. This article provides information on how simulation is carried out and presents the results.

34856 Investigating the starting modes of the GT-35 gas turbine plant. Ol'khovskii, G.G.; Povolotskii, L.V.; Kaplan, M.P.; Bumarskov, A.O.; Belov, A.I.; Chernomordik, L.I.; Korzh, P.I. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 8, 43-46(1976).

Translated from Teploenergetika; 23: No. 8, 57-60(1976).

The starting and loading procedures for the gas turbine (GT) part of the PGU-200 steam turbine-gas turbine plant both in an independent mode and in the combined plant were developed in the first period of commissioning, at the end of 1972 and the beginning of 1973. In order to facilitate starting, it was decided to lower the temperature of the gases, reduce the capacity of the starting unit, ensure matching operation of the compressor stages in the starting

modes, and avoid separation in the flow section and an increase in separation stresses. Provision is made for releasing part of the compressed air through antisurge valves and the inlet guide vanes of the compressor are adjustable. Air is released through the valves from after the third stage, from after the eighth stage, and from the outlet line. Results are presented of starting measurements using the same methods and instruments as for the GT thermal tests.

WASTE-FUELED SYSTEMS

34857 (EPRI-FP—678) Annotated bibliography on supplemental firing of municipal solid waste in electric utility boilers. Final report. Ball, D.A.; Beltz, P.R.; Smith, P.; Engdahl, R.B.; Reid, W.T. (Battelle Columbus Labs., Ohio (USA)). Feb 1978. Contract EX-76-C-01-2210. 27p. Dep. NTIS, PC A03/MF A01.

An annotated bibliography is presented of 86 articles on the subject of combined firing of refuse and conventional fossil fuels in utility boilers. The bibliography was compiled by machine searching various literature search services, including National Technical Information Service (NTIS), ERDA-RECON, Smithsonian Science Information Exchange (SSIE), Engineering Index, Chemical Abstracts, and EPA Air Pollution Technical Information Center (APTIC). In addition, some literature references were found by searching appropriate journals and by personal contact with in-house and outside solid waste conversion experts. In most cases, annotations were compiled from abstract information. Each article is indexed and categorized into one or more of seven subject areas. The bibliography does not cover other solid waste conversion subjects, such as incineration, pyrolysis, and gasification.

COMPONENTS

REFER ALSO TO CITATION(S) 34854, 35489, 35490, 35862, 35872

34858 50-Mw Olympus 593 to debut in early 1981. Farmer, R. *Gas Turbine World;* No. Spec. Adv. Suppl., 8-11(Mar 1978).

By maintaining design simplicity and avoiding expensive advanced technology complications, Rolls-Royce will be able to offer the Olympus 593 for 50-Hz and 60-Hz electrical generation and mechanical drive serice at a competitively low cost per kW installed. A discussion is given of design performance, packaged plant installation, maintenance and overhaul, and future growth.

34859 Power turbines designed for efficiency and reliability. Farmer, R. *Gas Turbine World;* No. Spec. Adv. Suppl., 16-18(Mar 1978).

By matching uprated and new generation gas generator efficiencies with single and multi-stage power turbines, Rolls-Royce has come up with a stable of engines ranging in unit size from 11,000 kW to 50,000 kW for 50- and 60-Hz power generation, mechanical drives and marine propulsion. Electric power generation designs and marine power turbine designs are discussed.

34860 Operational experience with feedwater containers. Adamsky, F.J. (Technischer Ueberwachungs-Verein Rheinland e.V., Koeln (Germany, F.R.)); Teichmann, H.D. (Rheinisch-Westfaelisches Elektrizitaetswerk A.G., Essen (Germany, F.R.)). *VGB Kraftwerkstech.;* **57**: No. 11, 759-773(Nov 1977). (In German).

A survey is presented of investigation results of 55 feedwater containers in 6 lignite-fired power stations made of H I, H II, and 17 Mn 4. Nondestructive crack examinations presented extensive cracks in the case of welded deaerators. Ductility measurements showed that this type of construction means extreme high stress peaks in the region of the deaerator joints. The feedwater container whose deaerator came off in 1971 with considerable consequences, was of this type, too. Information was elaborated how to avoid damage of this kind.

34861 Nonlinear digital modeling of dynamic processes of once-through boilers. Rubashkin, A.S.; Volkov, O.G. (ORGRES, USSR). *Teploenergetika (Moscow);* No. 8, 3-7(Aug 1977). (In Russian).

A description of the nonlinear digital model of a TGMP-324 boiler and transient characteristics for three levels of loading are presented. A comparison of the dynamics of the model and of the plant is given. The model is found to be suitable for the reproduction of complicated processes with load boosting and load shedding.

34862 Control of rotor warm-up in high-capacity steam turbines at thermal power stations by means of an analog model. Leizerovich, A.Sh.; Kozlov, V.N.; Mironov, V.D.; Davydov, N.I.; Vezenitsyn, Yu.N.; Filat'eva, R.I.; Ivanov, B.D.; Medvedeva, N.P.; Malev, V.V. (All-Union Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 8, 10-13(Aug 1977). (In Russian).

Computational, functional and structural diagrams of an analog device for controlling the warm-up of turbine rotors at thermal power plants are presented.

34863 Automation of startup of the K-500-240-2 turbine. Katsnel'son, V.B.; Pokhoriler, V.L.; Markova, A.N.; Tyurin, Yu.V. (Ural Polytech Inst, USSR). *Teploenergetika (Moscow);* No. 8, 28-31(Aug 1977). (In Russian).

A description is given of the system of automation of the startup of the K-500-240-2 turbine. The functional groups of the turbine startup and check valve warm-up automation and the control systems making part of these functional groups are described.

34864 Statistical analysis of the temperature fields of combustion production in combustion chambers of gas turbine plants. Lyubchik, G.N.; Volkotrub, S.F. (Kiev Polytech Inst, Ukr SSR). *Teploenergetika (Moscow);* No. 8, 31-35(Aug 1977). (In Russian).

Some methodical aspects of the analysis of the state of the field of combustion products in the combustion chambers of gas turbine plants are investigated. The usefulness of application of the tool of statistical physics is demonstrated. A method of linearization of the temperature field of combustion products is considered. The normalcy of temperature distribution is checked. The possibility of utilizing generalized statistics to describe a group of operating modes is demonstrated.

34865 Investigation of the cooling-down conditions of the elements of the gas-tight boiler TGMP-324 following shutdowns. Shmukler, B.I.; Livshits, M.A.; Vavilin, A.N.; Glusker, B.N.; Ivanov, N.V.; Mikhailov, S.Ya.; Nosov, G.N. (All-Union Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 8, 36-39(Aug 1977). (In Russian).

Characteristics of natural cooling-down of the gas-tight boiler TGMP-324 with finned water walls are presented and a comparison is made with boilers of identical capacity but with smooth-tube water walls. It is shown that, following boiler shutdown, impermissible temperature differences arise in joined elements. This causes a loss of tightness in the water walls. Measures, such as redesign and appropriate operating conditions, ensuring implementation of boiler shutdowns while maintaining the main criteria of reliability, are proposed.

34866 Investigation of aerodynamics of open fire-chambers on an isothermal air model of the K-50-40/14 boiler. Pet'ko, V.M.; Faershtein, D.G.; Gorbatko, P.A.; Semenov, M.K.; Tret'yakov, V.A. (Khar'kov Polytech Inst, Ukr SSR). *Teploenergetika (Moscow);* No. 8, 39-42(Aug 1977). (In Russian).

The effect of the direction of rotation of the primary and secondary air in counter-arranged double-volute-chamber burners on the degree of filling-up of the furnace volume is established. For this purpose, an isothermal air model of the K-50-40/14 boiler is used. Optimal variants of the counter-arrangement of burner devices are obtained. Practical recommendations are given on the layout of pulverized coal burners.

34867 Experience of application of furnace waterwall and radiative superheater washing with water in a shale-fired boiler. Stashkiv, M.G.; Gut, F.E.; Khimuk, B.S.; Gudkin, M.Z.; Komp, E.T. *Teploenergetika (Moscow);* No. 8, 45-48(Aug 1977). (In Russian).

Results of the experience of operating a boiler with steam purging of furnace waterwalls and superheaters, as well as with washing only furnace waterwalls with water are presented. It is found that steam blowing cannot ensure heating surface cleanliness that is necessary for reliable and economic operation of a shale-fired boiler. Washing with water raises the thermal efficiency of the waterwalls as well as boiler efficiency by approximately 0.5% as a result of the reduction of heat losses with exhaust gases.

34868 Evaluation of the possibility of protecting lower radiant sections of supercritical pressure boilers from external corrosion by metal oxide coatings. Zhabo, V.V.; Zeger, K.E. (Minenergo, USSR). *Teploenergetika (Moscow);* No. 8, 48-50(Aug 1977). (In Russian).

Results of application of a method of reducing waterwall tube corrosion in supercritical-pressure boilers are presented. The method is based on the use of metal oxide coatings. Concrete recommendations on the utilization of this method of improving the reliability of operation of waterwall tubes are given. In particular, coatings containing magnesium oxide as an active component are tested. It is shown that the period of existence of metal oxide coatings without their restoration in test conditions amounted to 96-100 h. This ensures protection of LRS in the starting period.

34869 Investigation of the rate of steam and water corrosion of steels of once-through supercritical pressure boilers. Storonskii, V.I.; Avdeeva, A.A. (L'vov Polytech Inst, Ukr SSR). *Teploenergetika (Moscow);* No. 8, 58-60(Aug 1977). (In Russian).

The rate of steam and water corrosion of steels of a supercritical pressure boiler is measured by the content of hydrogen in water and steam using a chromatographic hydrogen meter developed at the ENIN (Krzhizhanovskiy Institute of Energy). Hydrogen concentrations in steam and water samples taken simultaneously at 15 points of the boiler tract are measured. A table shows the rate of corrosion of different parts of the tract. It is shown that the rate of steam and water corrosion of steel 12CrMoV increases according to an exponential law with an increase in the temperature of the medium.

34870 Effect of instability of fire-chamber waterwall conditions on their operational reliability. Dashkiev, Yu.G.; Mikhlevskii, A.A. (Kiev Polytech Inst, Ukr SSR). *Teploenergetika (Moscow);* No. 8, 75-77(Aug 1977). (In Russian).

A quantitative evaluation of the instability of the calorific intensity of the radiative heating surfaces in supercritical pressure boilers when burning different types of fuel is given. A method is presented permitting instability of the calorific intensity of temperature conditions to be accounted for when carrying out strength calculations and determining the length of the periods between fire-chamber waterwall washings.

34871 Ways to improve economic efficiency of small heat turbines and combined heat and power plants. Terent'ev, I.K.; Budnyatskii, D.M.; Osipenko, V.N.; Vodichev, V.I.; Benenson, E.I.; Ryzhkov, V.K.; Nezhentsev, Yu.N.; Lisnyanskii, F.A. (Cent Sci Res Boiler and Turbine Inst, USSR). *Teploenergetika (Moscow);* No. 7, 2-6(Jul 1977). (In Russian).

Utilization of district heating turbines to control the electric load graph is analyzed. Ways to compensate for temporary reductions of steam bleeding for district heating to produce additional power are discussed. Optimal characteristics of the low-potential part for the 175-180 MW turbines are selected. Finally, utilization of the heat derived from the combined heat and power plants to heat greenhouses is considered.

34872 Investigation of the economic efficiency of the close-coupled turbine plant, K-800-240-2 LMZ, after partial reconstruction. Komarov, N.F.; Kintin, E.S.; Azhikin, A.G.; Borisova, N.N. (All-Union Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 7, 6-9(Jul 1977). (In Russian).

Results of supplementary thermal tests of the prototype of the close-coupled turbine plant K-800-240-2, made by the Leningrad Metal Works, after partial redesign, are presented. An evaluation is given of the effectiveness of the measures taken to improve the design of some elements of the turbine plant. As a result, turbines with the maximum capacity of 850 MW, matching in performance the best foreign turbines of similar capacity, are to be produced.

34873 Improvement of the efficiency of the heating systems for flange joints of steam turbine casings. Izrailev, Yu.L. (All-Union Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 7, 14-18(Jul 1977). (In Russian).

Structural, thermal diagram, and layout solutions for the flange joint heating systems of high-pressure and medium-pressure cylinders are presented. They are marked by great simplicity and efficiency. The main principles of designing such systems are formulated. The expediency of employing these systems in turbines used at thermal power plants is demonstrated.

34874 Specific features of vibrations of rotor blades of high-pressure and medium-pressure cylinders of high-capacity turbines. Borishanskii, K.N. (Leningrad Mach Works, USSR). *Teploenergetika (Moscow);* No. 7, 21-24(Jul 1977). (In Russian).

Vibration characteristics of rotor blades designed integral with shroud seats are considered. It is shown that, to improve vibration reliability, it would be advantageous to join all the blades of a stage into a single packet. Formulas are presented for the calculation of the work of the disturbing forces and conditions are considered which would guarantee the efficacy of joining the blades into a closed circle in a packet.

34875 Effect of the shroud seal design on gas dynamic excitation of low-frequency vibration of a turbine rotor. Olimpiev, V.I. (Cent Boiler and Turbine Inst, USSR). *Teploenergetika (Moscow);* No. 7, 24-28(Jul 1977). (In Russian).

A refined scheme for the one-dimensional flow of a twisted annular duct of variable height is proposed. Differential relations are obtained connecting the hydrodynamic reaction of the duct with rotor displacements. An algorithm is proposed for the calculation of the hydrodynamic reaction of the shroud seal under the conditions of a circular steady-state rotor precession.

34876 Investigation of unsteady convective heat transfer in channels. Kapinos, V.M.; Slitenko, A.F.; Tarasov, A.I. (Khar'kov Polytech Inst, Ukr SSR). *Teploenergetika (Moscow);* No. 7, 68-70(Jul 1977). (In Russian).

Results of tests are presented on the effect of the unsteadiness of thermal and hydrodynamic boundary conditions on the heat transfer coefficient during the flow of a fluid in a flat channel.

34877 Considerations concerning the start-up of supercritical boilers. Dodero, G.; Fossati, G.; Parini, G.; Zambelli, A. (Impianti Term e Nucl, Milano, Italy). *Energ. Elettr.;* **54**: No. 7/8, 367-371(1977). (In Italian).

The paper emphasizes the measures that should be taken both when staring and during the operation in order to make the start-up of supercritical boilers equipped with recirculating pumps safer and more reliable.

34878 Effect of three-phase system faults and faulty synchronisation on the mechanical stressing of large turbine-generators. Hunt, A. (GEC Turbine-Generators Ltd, Stafford, Engl). *Rev. Gen. Electr.;* **86**: No. 7/8, 558-580(1977).

The paper examines transient torque phenomena which can arise in shaft systems of large synchronous generators following a system disturbance. Fault clearance and faulty synchronization are considered. Results relating to peak shaft torques at various turbine, generator and exciter interfaces as a function of the duration of the applied three-phase short-circuit are summarized.

34879 Manufacture of rotor forgings for high-capacity power units. Onishchenko, A.K.; Tikhomirov, N.V.; Kagan, E.S.; Gorovaya, E.K. *Energomashinostroenie;* No. 8, 20-24(1977). (In Russian).

Principal problems of technology of rotor blank forging for high-capacity generators in unit-forged and welded-and-forged versions are considered. The processes of manufacture of the forgings according to the two technologies introduced into industry are analyzed. It is found that when unit-forged rotor blanks are made from ingots having a mass of 235 t each, drawing in cut-out blocks 1400 mm wide and barrel reduction of $K=5$ guarantees high quality of the finished product. A generator rotor blank with a mass of 236 t in the welded-and-forged version has been made for the first time in world practice. The reduction of the welded joint amounts to $K=1.8$.

34880 Turbine stage load sensors. Volynskii, M.M.; Karliner, V.M. ("Glavenergoremont", Khar'kov, Ukr SSR). *Energomashinostroenie;* No. 8, 39-40(1977). (In Russian).

A sensor is considered whose input signals are steam pressure before and after a turbine stage (or groups of stages, i.e. a section), and whose output signal is proportional to the stage capacity. This sensor is used in the protection system of the pre-bleeding stage of two turbines, the VK-100-5 LMZ and VK-100-6 turbines.

34881 Analytical determination of aerodynamic forces in seals affecting the low-frequency vibration of turbosets. Rozenberg, S.Sh. (Cent Boiler and Turbine Inst, USSR). *Energomashinostroenie;* No. 8, 14-16(1977). (In Russian).

A further development of the method of calculation of transverse aerodynamic forces arising in labyrinth seals as a result of the spiral effect and affecting the low-frequency vibration of turbosets is presented.

34882 Effect of the pressure drop on the phase slipping in axial turbine gaps. Deich, M.E.; Khizanashvili, M.D. (Moscow Energ Inst, USSR). *Energomashinostroenie;* No. 8, 9-11(1977). (In Russian).

Results of experimental investigations are presented regarding the interrelations between dispersion, velocity, and liquid phase slippage coefficients in the space after the nozzle cascade of a turbine with the S-90-I5A profile. A detailed analysis of the measurement results obtained under the conditions of different cascade pressure drops is given.

34883 Main aspects of boiler design automation at the present stage. Litvak, D.B. *Energomashinostroenie;* No. 8, 2-5(1977). (In Russian).

The main principles of computer-aided design of boilers using ES ("unified series") computers and relying on the accumulated experience of automation are set forth. A broad system of computer-aided design is proposed. It is based on the modular principle and the dialog system using a specialized input language for communication between the designer and the computer.

34884 Influence of the regenerative bleed of steam on efficiency of low pressure stages of steam turbines. Simoyu, L.L.; Lagun, V.P.; Nakhman, Yu.V.; Markozov, N.D. *Therm. Eng. (USSR) (Engl. Transl.);* **24**: No. 2, 40-44(1977).

Translated from Teploenergetika; 24: No. 2, 35-39(1977).

The features of operation of the low pressure stages of steam turbines with allowance for the influence of regenerative steam bleed were explored. Results are given of investigations which were conducted on an experimental model (scale 1:3) steam turbine. The efficiency of both post-bleed and pre-bleed stages can be increased by adapting the post-bleed stage to conditions of operation with steam bleed. In solving this problem it is necessary first of all to improve conditions of flow in the peripheral and root regions. In this case, besides appropriate selection of the integral exhaust area of the cascade of fixed blades for a specified quantity flow of steam, a design measure is redistribution of area over the height by decreasing angles in the upper and by increasing them in the lower zones of the stage. This means that if the initial stage is designed without allowance for the influence of bleed, arranged with constant angle over the height, then is is advisable to introduce the socalled reverse twist, and for a stage with an increasing angle from the root to the periphery--to decrease the gradient of its variation.

34885 Investigation of the efficiency of the low pressure cylinder of the LMZ K-200-130 turbine before and after modification. Marchenko, Yu.A.; Khrabrov, P.V.; Rozenberg, S.Sh. Sandovskii, V.B.;

Efimov, A.I.; Sorokin, N.A. *Therm. Eng. (USSR) (Engl. Transl.);* **24**: No. 3, 34-38(1977).

Translated from Teploenergetika; 24: No. 3, 46-51(1977).

The modification of the K-200-130 steam turbine, 200 MW in capacity, carried out by Leningrad Metal Working Plant (LMZ) in collaboration with Moscow Power Institute (MEI), is one of the important steps in the effort to reduce specific consumption of fuel at power stations. According to test data, the absolute efficiency increased after the modification by 3.8%, which virtually corresponds to the design value. At the same time, after the modification the efficiency of the group of the first two stages increased by 1.5%, and of the "Baumann stage--last stage" group by 4.2%. The detailed gas-dynamic investigations carried out showed that the efficiency of the low pressure flow section with the Baumann stage of the K-200-130 turbine after the modification became comparable with the efficiency of an ordinary LPC, but with a longer blade of the last stage. The better efficiency of the LPC was due to a fall in the losses in the guide blades of all stages as a result of the replacement of the blades by ones specially profiled for the conditions of operation, compression of the flow towards the root cross sections of the stages due to the more favorable shape of the meridional bounding surfaces, and elimination of leaks in the guide blades of the Baumann stage owing to complete separation by the separation by the separating wall, as well as owing to improvement of flow in the root cross sections of the last stage and decrease in losses with leaving velocity in connection with increase in the proportion of flow through the lower part.

34886 Analytic calculations for magnetic field of excitation winding of turbogenerator with low-magnetic rotor. Vazhnov, A.I.; Grinbaum, I.N. *Sov. Electr. Eng. (Engl. Transl.);* **47**: No. 7, 31-35(1976).

The scalar potential is used to obtain an analytic solution of the Laplace equation in calculating the magnetic field of a turbogenerator having a low-magnetic rotor; allowance is made for saturation of the toothless stator core on the assumption that the permeability components are analytic functions of the radius. The no-load characteristics of a turbogenerator with low-magnetic rotor are calculated.

34887 Influence of rotor compression-assembly design in high-power turbogenerator on end-zone electromagnetic and thermal fields under a nonsymmetric load. Brynskii, E.A.; Danilevich, Ya.B.; Popov, V.V.; Chernyshev, N.N. *Sov. Electr. Eng. (Engl. Transl.);* **47**: No. 7, 47-52(1976).

Results are reported for investigations of the electromagnetic and thermal end-zone fields for rotors of large turbogenerators having a compression ring fitted on the rotor barrel. The influence of the method used to attach compression rings on the distribution of local hot spots in the rotor end zone is evaluated.

34888 Measuring the relative core-frame vibration displacements in large turbogenerators. Gavrilov, L.G. *Sov. Electr. Eng. (Engl. Transl.);* **47**: No. 7, 57-59(1976).

Commercial sensors are used as the basis for developing a special sensor to monitor and investigate the relative vibration displacements of the active steel and frame of a stator core. Data are given for vibration displacements of the active-steel cylinder with respect to the frame of stator cores in large turbogenerators; they are obtained by the proposed method.

34889 Analysis of vibration state in end sections of turbogenerator stator winding. Pikul'skii, V.A.; Tsvetkov, V.A. *Sov. Electr. Eng. (Engl. Transl.);* **47**: No. 7, 60-65(1976).

A method is given for the theoretical analysis of the vibration state in end sections of a turbogenerator stator winding. It iis based on multivariant calculations of vibrations in an individual and arc. The latter is represented as a homogeneous orthotropic curvilinear bar having elastically damped attachment fittings. The harmonic oscillations of the curved bar are considered in a rectilinear coordinate system, one axis being identified with the tangent to the bar longitudinal axis at each of its points, while the other two run in the directions of the maximum and minimum cross-sectional rigidities. It is found that there is a substantial effect of winding attachment conditions at the slot exit on vibration displacements at the beginning of the evolvent. At the same time, this has almost no effect on the natural frequencies.

34890 Calculating the natural vibration frequencies of a turbogenerator stator core. Glazenko, A.V.; Shkol'nik, V.E. *Sov. Electr. Eng. (Engl. Transl.);* **47**: No. 7, 74-77(1976).

A calculation method is proposed for the natural vibrations of a turbogenerator stator core; it is based on the theory of a thick circular ring of orthotropic material.

34891 Operation of large turbogenerators with damper system in nonsymmetric regimes. Khutoretskii, G.M.; Kosachevskii, V.I. *Sov. Electr. Eng. (Engl. Transl.);* **47**: No. 7, 5-8(1976).

The distribution of temperature rises over the surface of the rotor barrel in large turbogenerators is considered for nonsymmetric regimes. The factors determining these rises are given, together with the permissible value of the $I_2^2 t$ criterion for machines with rotor end zones of different designs.

34892 Technical-economic effectiveness of various ways of increasing the dynamic stability of large turbogenerators. Burtseva, G.E.; Glebov, I.A.; Duganova, L.I. *Sov. Electr. Eng. (Engl. Transl.);* **47**: No. 7, 9-15(1976).

The technical-economic effectiveness of various ways of increasing the maximum amount of power that can be sent over transmission lines is considered. The analysis method consists in the following: for an elementary system (generator-transformer-double circuit line-bus of infinite capacity, the maximum amount of power that can be transmitted without the use of any devices to increase the stability, and in the presence of the following: a fast-response excitation-control system, high-speed control of steam-turbine power, shunting static capacitor units, and synchronous compensators. The effectiveness of increasing the maximum transmissible power by installing turbogenerators having lowered values of synchronous and transient inductive reactances is also considered. It is concluded that the most effective way of increasing maximum transmissible power is to use fast-response control of steam turbines. Where the power system requires reactive power, the utilization of synchronous compensators to increase maximum transmissible power is the most economical.

34893 Optimal selection of basic dimensions of four-pole turbogenerators. Levitskii, A.K. *Sov. Electr. Eng. (Engl. Transl.);* **47**: No. 7, 16-23(1976).

Optimization problems pertaining to the choice of basic dimensions of four-pole turbogenerators are solved by similarity-theoretic methods.

34894 Resistance of hydroelectric-generator damper-winding bars. Ter, G.; Bidzhamov, Ya.G.; Ovakimyan, A.S. *Sov. Electr. Eng. (Engl. Transl.);* **47**: No. 7, 36-39(1976).

A method is considered for determining the displacement coefficient without the use of any additional assumptions. The Georgian Scientific-Research Institute for Hydroelectric Plants has developed and adjusted a twelve-ton fragmentary model for the pole of a large high-utilization hydroelectric generator that permits detailed investigation of the mechanism by which additional losses are released for a spectrum of nonsynchronous fields, electromagnetic loads, and pole slot-zone geometry that do not differ from the actual values. The model may be used with fully acceptable accuracy to measure the losses in the material of damper bars due to the current flowing through them, as well as the losses in the steel on leakage flux paths closing around the damper bars.

34895 Method of designing ring seals of turbogenerator rotors. Tokar, I.Ya.; Spivak, B.V. *Sov. Electr. Eng. (Engl. Transl.);* **47**: No. 7, 53-56(1976).

An engineering method is given for designing rotor ring seals that makes it possible to obtain all working parameters with allowance for the nonsteady-state nature of the lubrication process. Certain recommendations for seal design are given.

34896 Determining flow kinematics in impellers of turbogenerator axial-flow fans. Belopol'skii, V.A. *Sov. Electr. Eng. (Engl. Transl.);* **47**: No. 7, 70-73(1976).

Experimental data are processed statistically to obtain a formula for the flow deviation angles in the impellers of turbogenerator axial-flow fans. A method is proposed for determining flow kinematics in the impellers of axial-flow fans. 10 refs.

34897 Features of experimental dynamic characteristics of the TGMP-314 steam generator in a 300 MW unit. Koichu, M.B. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 4, 18-23(1976).

Translated from Teploenergetika; 23: No. 4, 32-37(1976).

In analysis of data of dynamic tests on the TGMP-314 gas and oil fired steam generator designed to operate under supercritical steam conditions, special attention was paid to the features of its dynamic characteristics. Tests were conducted on the prototype of the steam generator installed at Tripol'e central power station. Response curves with respect to steam temperatures and steam pressure for the majority of disturbances are of a complex nonmonotonic shape, which makes it impossible to evaluate them with the generally accepted characteristics (conventional delay and time constant) and complicates the setting of controllers. Variation in heat release in one half-furnace considerably affects the parameters of the medium of the flow in the other half-furnace. Temperature of reheated steam is affected not only by variation in heat release in the furnace but also by variation in feedwater flow. Variation in flow of total air appreciably affects temperature and pressure of steam in the main superheating and reheating circuits. Response curves with respect to temperature and pressure with disturbance imposed by the fan for recirculation of flue gases are of complex fluctuating shape, which is explained by superposition of two factors: redistribution of heat between the superheating and reheating circuits; and the influ-

ence of variation in pressure and temperature of the heating surfaces adjoining the zone of maximum specific heat.

34898 Improving the reliability of the lower radiant section when burning oil. Boev, A.F.; Didenko, Yu.K.; Karachevtsev, V.S.; Paperno, S.I.; Stolov, M.A.; Korotkin, P.D.; Staichenko, V.P. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 6, 21-23(1976).

Translated from Teploenergetika; 23: No. 6, 23-26(1976).

Introducing the recirculating flue gases through the peripheral channel of the burner enables one uniformly to reduce the local heat flux by not less than 70 x 10^3 W/m^2 with increase in recirculation to 26%, without impairing the combustion process. As a result of lowering the local heat fluxes the LRS heat absorption is lowered by 10 to 15% and the temperature of the loops at the LRS outlet by 20 to 25°C. Lowering the heat absorption of the LRS appreciably raises the reliability of its operation and simplifies adjustment of the LRS as a result of the increase in the allowable thermal stratification. Introducing the recirculating gases through the burner is a promising method of uniformly lowering the local heat fluxes and of improving the LRS reliability. To reduce the heat fluxes at the points where the flame is in contact with the waterwalls it is advisable to combine introduction of recirculating gases through the burner with introduction of gases to this zone.

34899 Distribution of residence time of fuel in coal-burning equipment and taking it into account in determination of combustion efficiency. Khavkin, Yu.I.; Nekhamkin, Yu.Z.; Strelkov, B.D. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 6, 24-27(1976).

Translated from Teploenergetika; 23: No. 6, 30-33(1976).

A formula is derived for calculating the combustion efficiency of coal combustors. The equation gives a more accurate value of the residence time of a particle in the combustion chamber and takes the reaction time into account. The results can be used to determine separately the time for preparation of the combustible mixture and the time for burning it. (PMA)

34900 Theoretical and experimental investigation of separation of condensed moisture from curvilinear two-phase flow. Sheikin, S.I.; Ushakov, S.G.; Klepikova, T.M. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 6, 54-57(1976).

Translated from Teploenergetika; 23: No. 6, 56-58(1976).

Output and efficiency of steam separating arrangements and in particular of starting integral separators in steam generators are improved mainly by means of experiments since the mechanism of separation of phases, of flow and of removal of the film has not yet yielded to analytical description. At the same time there are grounds for determination by calculation of the zone of active separation of moisture in curvilinear channels by means of calculating the paths of droplets. The main variables are the size of the droplet, diameter and radius of curvature of the channel, flow and droplet velocities at the channel inlet. Of practical interest is the relation of the separating capacity of the channel (ratio of mass quantity of moisture which has reached the channel wall to the overall quantity of moisture at the inlet to the channel) with the parameters of the steam/water flow. To calculate the path of the droplets, a mathematical model was developed using dimensionless differential equations of motion of a droplet, derived only with those simplifications which make it possible to use the model with numerical methods on a computer. Experimental checking of the results was carried out on a steam/water rig for a range of parameters.

34901 Propsects for the development of tubular air heaters for high-capacity steam generators. Lipets, A.U.; Lafa, Yu.I.; Kuznetsova, S.M.; Krasnov, B.M.; Sotnikov, I.A.; Fedosov, A.Z.; Gureev, A.M.; Dimov, G.P. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 6, 7-11(1976).

Translated from Teploenergetika; 23: No. 7, 25-29(1976).

Regenerative air heaters have a number of merits: they are small in mass and in overall dimensions, have high resistance to low temperature corrosion and good maintainability. However, they also have a number of important shortcomings. A discussion is given of various types of air heaters including compact air heaters, cross air heaters, and cascade air heaters.

34902 Thermal operation of cyclone primary furnaces with different methods of introducting and atomising oil. Motin, G.I.; Grishutin, K.S. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 6, 25-30(1976).

Translated from Teploenergetika; 23: No. 7, 40-45(1976).

A comparative industrial investigation was made into the thermal operation of cyclone extension furnaces of a steam generator with concentrated and dispersed introduction of fuel. The first stage of the investigation was carried out with atomization of oil by mechanical atomizers, two of which were installed in each of the two tangential nozzles of the cyclone extension furnaces (at a distance of 330 and 1170 mm from the upper edge of the nozzle). In the second stage, the combustion of oil with dispersed and uniform introduction into the cyclone extension furnaces by panel-type steam operated oil atomizers was investigated. Distributed introduction of fuel with cyclone combustion of oil appreciably increases completeness of heat release within the limits of an extension furnace, leading to further decrease in difference between emissivity characteristics of flames of liquid and gaseous fuels. The use of panel-type steam operated oil atomizers, ensuring broadening of the control range of operation of the steam generator, makes it possible considerably to decrease carbon concentration in the flame and to decrease its emissivity.

34903 Assembly of logical control units for automation of high-capacity generating units. Mironov, V.D.; Safronnikov, S.A.; Panfilov, V.A.; Strukov, A.P.; Gorshenin, N.A.; Tangribergenov, T.B.; Morgenshtern, L.S. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 8, 1-6(1976).

Translated from Teploenergetika; 23: No. 8, 2-7(1976).

One of the typical trends in development of present-day power supply systems is the increasing nonuniformity of power consumption. Even in the near future the vast majority of generating units must be shut down every week and, many of them, every day, and they must be started fast and at the same time. Under these conditions the so-called "all purpose" automation of generating units becomes increasingly more economically effective and in the future technically indispensable. A discussion is given of the structure and functions of such control systems and the design and construction of the logic assemblies.

34904 Control system of a 300 MW unit with a once-through steam generator in relation to operational conditions in a combined mode of variation in pressure. Davydov, N.I.; Dubinskii, A.V.; Kozyreva, E.G.; Melamed, A.D.; Chesnokovskii, V.Z. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 8, 7-15(1976).

Translated from Teploenergetika; 23: No. 8, 14-22(1976).

With a change of the generating unit to operation at variable pressure, the following additional requirements of the automatic control system arise. The required static dependence of variation in power of the generating unit on deviation of frequency in the power supply system should be preserved also with variable pressure of the steam. The normal problem of maintaining steam pressure at the rated level remains only within the range of high loads. Within the range of lower loads the position of the turbine control valves should be maintained constant, instead of pressure. On reaching the minimum allowable level of pressure the problem arises again of maintaining pressure, now at minimal level. The controllers maintaining the temperature conditions in the intermedite section of the path of the steam generator should ensure variation in specified values of temperatures controlled by them according to steam pressure. For this reason it is advisable to introduce to these controllers an additional setting signal from steam pressure. Operation, design, and test results of the control system are delineated.

34905 Linear mathematical model for calculating the dynamics of a once-through steam generator in a start up. Krashennikov, V.V.; Koverman, G.I.; Dumnov, V.P.; Cherepanova, I.M. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 8, 16-20(1976).

Translated from Teploenergetika; 23: No. 8, 35-38(1976).

The linear mathematical model of a once-through steam generator in operation with steam separation described gives an accuracy sufficient for practical purposes of the variations in flowrate and pressure of steam with heat input disturbances in the following cases: (1) when enthalpy at the inlet of the integral valve i'/sub IV/ $\leqq$ 440 kcal/kg and deviation of this enthalpy Δi'/sub IV/ $\leqq$ 70 kcal/kg; and (2) within the range 440 < i'/sub IV/ $\leqq$ 600 kcal/kg and when Δi'/sub IV/ $\leqq$ 50 kcal/kg. In calculation of deviations of temperature of the medium at the inlet of the integral valve in the zone of maximum specific heat with the aid of the linear mathematical model, the provision of a nonlinear component at the outlet of this model, taking into account the dependence of specific heat of the medium on enthalpy and pressure, is recommended. The temperatures of the medium response curves calculated in this way are in satisfactory agreement with experimental data at Δi'/sub IV/ < 40 kcal/kg. The linear mathematical model is applicable for calculation of deviations of steam temperature in the superheater with heat input disturbances which lead to variation in this temperature up to 100°C.

34906 Testing the annular combustor of the NK-8 aero-engine on natural gas. Tumanovskii, A.G.; Kovalev, V.N.; Skuridin, V.G.; Mingaleev, F.M. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 8, 47-50(1976).

Translated from Teploenergetika; 23: No. 8, 60-64(1976).

At the present time, design organizations and the turbine construction works are working on the building of land gas turbine plants using aero-engines. Utilizing in this way the scientific developments in the field of aviation and the abundant operational experience in aviation leads to a considerable economic effect. Based on the results of testing the NK-8 combustor on natural gas it may be noted that the use of an annular combustor with series introduction of air to the combustion zone affords the possibility of increasing considerably the volumetric and cruss sectional heat release rates, appreciably reducing the dimensions and improving the layout of the gas turbine plant. Test results include a gas temperature of 1350°C

with a combustion efficiency of near 100%, relative pressure losses approximately 3%, overall nonuniformity factor of the temperature field = 16 to 18%, and maximum wall temperature of the flame tube = 750°C.

34907 Investigating the process of combustion of heavy fuel oil in a high-capacity combustion chamber. Asoskov, V.A.; Murashov, A.F. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 9, 47-50(1976).

Translated from Teploenergetika; 23: No. 9, 62-66(1976).

Comparative investigations of different versions of the head section of the flame tube of a high-capacity combustion chamber demonstrated the possibility of high-capacity combustion of heavy fuel oil with stepwise admission of air through the head section. The optimum version has a supply of 25% of the primary air through the swirler and the remainder through the concentrically arranged annular slots in the cone. It is very difficult entirely to prevent smoke in the flue gases and the formation of carbon during no-load operation since the largest droplets are not fully evaporated in the combustion zone and precipitate onto the cold walls. While it is possible to reduce the formation of carbon in the head section, it is only possible entirely to prevent smoke in the exhaust gases at low temperatures by intensification of combustion of the atomized fuel or by increasing the dimensions of the chamber.

34908 Tabular data for calculating burnout when boiling water in uniformly heated round tubes. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 9, 77-79(1976).

Translated from Teploenergetika; 23: No. 9, 90-92(1976).

In compiling the tables, the following concepts were used as a basis. Burnout is caused by the discontinuation of contact of liquid with the heating surface. It may set in due to hydrodynamic and thermal disintegration of the wall-adjacent steam-liquid layer and the formation of a steam film or due to complete evaporation of the liquid film running along the wall, which according to operational parameters may take place both under conditions of separation of droplets from the flow core and in the absence of wetting. Table 1 gives critical heat flux densities, and Table 2 gives values of limiting steam contents corresponding to burnout associated with the drying of the liquid film.

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 34871

34909 Procedure for taking into account statistical probability factors in selecting output of steam generators of industrial/space heating heat and power stations for a future period. Sobol, I.D.; Vinogradov, Yu.I. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 6, 40-43(1976).

Translated from Teploenergetika; 23: No. 7, 52-56(1976).

Selection of the main equipment for industrial/space heating heat and power stations amounts to determination of the structure of two assemblies: turbine units and steam generators. The type and number of turbine units of a station are in the functional dependence, which is being optimized; they depend on the size and composition of the heat demands. Determination of optimal unit steam generator output of a heat and power station for a future period is an indeterminate probability engineering and economic problem. Statistical processing of available data makes it possible to obtain arithmetic mean and mean probability estimates of expected unit output. Analysis of contingent strategies with the aid of the apparatus of engineering and economic investigations will make it possible with allowance for the indeterminacy of initial data to develop the most reliable and complete procedure for selecting the type of steam generator for the remote future.

ECONOMICS

REFER ALSO TO CITATION(S) 34956, 35463

OFF-PEAK ENERGY STORAGE

34910 Electrochemically regenerative hydrogen-chlorine energy storage system for electric utilities. Gileadi, E.; Srinivasan, S.; Salzano, F.J.; Braun, C.; Beaufrere, A.; Gottesfield, S.; Nuttall, L.J.; Laconti, A.B. (Brookhaven Natl Lab, Upton, NY). *J. Power Sources;* **2**: No. 2, 191-200(Dec 1977).

Electrolysis of HCl and storage of hydrogen and chlorine is proposed as a means for energy storage for the electric utility industry. An economic evaluation is presented which shows that the system has a clear advantage over the hydrogen-air storage system and is comparable in cost to gas turbines. The system is flexible, allowing both energy storage and hydrogen production for industrial purposes. 11 refs.

FUELS

34911 (TID—28039) Methane utilization from coalbeds for power generation. Quarterly technical progress report, September 1—December 1, 1977. Sturgill, C.L. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Advanced Energy Systems Div.). 1977. Contract EY-77-C-21-8098. 16p. Dep. NTIS, PC A02/MF A01.

Progress is reported in a program designed to demonstrate the economic utilization of mine gas (a diluted mixture of methane and air) as a fuel for gas turbine/electrical generator conversion of the mine gas to electrical energy. The work scope provides for the installation and operation of a system based on existing components usage and is divided into three phases. The first two phases are required to complete all design, procure parts and assemble the system at the site. The remaining phase is devoted to operation of the system at the site, measuring performance, and documenting the overall program in a final report.

34912 Power-heat coupling: coal, oil, and natural gas for four turbines and four boilers. *Energie;* **29**: No. 5, 146-150(May 1977). (In German).

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When extending their Munich works in 1970, Messrs. Pfanni converted from coal to a natural gas furnace which, due to its low environmental pollution, required only a 25 m stack on the 25 m boiler house, while a heavy fuel oil furnace would have required a 125 m stack. However, in case of a shortage in the natural gas supply, immediate switch-over to light fuel oil kept in a 100 m^3 tank is possible; furthermore, the old, coal-fired boilers may take up operation again at any time, so that the 'security of supply' is guaranteed by coal, oil, and natural gas. The new boiler generates a maximum of 80 t steam/h at a temperature of 500°C and a pressure of 67 bar. The extraction backpressure turbine generates 8 MVA, 10 kV and requires 10 to 12 kg stream /kWh.

34913 Results of comprehensive improvement of 300 MW generating units at Karmanovo central power station. Abdurashitov, Sh.R.; Filat'eva, I.A.; Gavrilov, A.F.; Zeger, K.E.; Efimochkin, G.I.; Khakimov, A.G.; Krokhalev, B.M. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 4, 6-9(1976).

Translated from Teploenergetika; 23: No. 4, 5-8(1976).

One of the very important goals set for the Soviet power industry in the tenth five-year period is to reduce specific fuel consumption for the power industry to 325 g/kWh. The reaching of this goal will depend in many respects on the level of efficiency and reliability of the high-capacity generating plants constructed in previous years. In this connection the experience with comprehensive improvement of 300 MW units operating on gas and oil, carried out at Karmanovo power station in 1970 to 1975 is of great interest. Results are presented of improvement of the 300 MW units at Karmanovo power station, 1800 MW in overall capacity, which operate on liquid fuel. About thirty significant technical improvements directed at increasing the efficiency, reliability, and flexibility generating equipment were made.

ENVIRONMENTAL ASPECTS

THERMAL EFFLUENTS

34914 Influence of discharge of heated water on oxygen concentration in the water supply source of a thermal power station. Berman, L.D. *Therm. Eng. (USSR) (Engl. Transl.);* **24**: No. 3, 46-49(1977).

Translated from Teploenergetika; 24: No. 3, 64-67(1977).

At thermal power stations with once-through water supply and with a closed circuit type cooling water system with a cooling pond, the heating of the cooling water in the turbine condensers does not lead to loss of oxygen in the water taken from the water supply source. Within the system of water supply to the power station (excluding the water source or water reservoir) considerable loss of oxygen from the cooling water is possible when it flows through a long open discharge channel. This loss of oxygen is to a considerable extent restored, however, thanks to aeration at the water discharge point. The most depressed concentration of oxygen in water due to decrease of its solubility is possible in the case of surface water discharge over the initial section of a transit stream in the cooling pond when the excess of natural temperature of the water is minimal. Decrease in oxygen concentration in water of a natural source or of a water reservoir, occasionally observed, to a level unfavorable for the ecological system and sanitary state of the water reservoir or stream is normally caused not by loss of oxygen from the water supply system of the power station or by the heating of water in the source but by the influence of other accompanying factors, which becomes greater with heating of water in the reservoir.

NOXIOUS GAS AND PARTICULATE ABATEMENT AND CONTROL

34915 (EPA—600/9-78-004) **EPA/DOE symposium on high temperature high pressure particulate control.** (Department of Energy, Washington, D.C. (USA); Environmental Protection Agency, Research Triangle Park, N.C. (USA). Industrial Environmental Research Lab.). 1977. 632p. (CONF-770970—). Dep. NTIS, PC A99/MF A01.

From EPA/ERDA symposium on high temperature/pressure particulate control; Washington, DC, USA (20 Sep 1977).

Twenty-one papers were presented at the meeting. A separate abstract was prepared for each of 18 papers. Two papers appeared previously in ERA. (LCL)

34916 (EPA—600/9-78-004, pp 13-32) **Tolerance of large gas turbines to rocks, dusts, and chemical corrodants.** Sverdrup, E.F.; Archer, D.H.; Menguturk, M. (Westinghouse Research and Development Center, Pittsburgh). 1977.

From EPA/ERDA symposium on high temperature/pressure particulate control; Washington, DC, USA (20 Sep 1977).

In EPA/DOE symposium on high temperature high pressure particulate control.

An order of magnitude estimate of the particle concentration that can be allowed in the gas flowing through large industrial gas turbines for combined-cycle electric utility service can be made. The estimate is based on theoretical models that predict the rates of arrival of submicron particles on the blade surfaces and assumptions about the quantity of material that will stick. The estimate is also based on calculations of the trajectories of micron sized particles and estimates of particle impact damage to turbine blading. Hard data, taken under conditions simulating turbine operation is needed to calibrate these models. Cleaning of the turbine expansion gas to 0.002 grains/scf with particles larger than six microns in diameter effectively removed is our best current guess as to the turbine expansion gas cleanliness required. Strict attention must also be given to controlling sodium compounds to about 50 parts per billion by volume in the expansion gas.

34917 (EPA—600/9-78-004, pp 61-86) **High temperature and pressure effects on particle collection mechanisms.** Parker, R.D. (Air Pollution Technology, Inc., San Diego, CA); Calvert, S.; Drehmel, D.C. 1977.

From EPA/ERDA symposium on high temperature/pressure particulate control; Washington, DC, USA (20 Sep 1977).

In EPA/DOE symposium on high temperature high pressure particulate control.

High temperatures and pressures affect the physical mechanisms by which particles are removed from gas streams. The theoretical basis for predicting high temperature and pressure effects on particle collection mechanisms is examined. In general particles larger than a few tenths of a micrometer in dia appear to be more difficult to collect at high temperature and pressure than at standard conditions. Experimental data are needed to confirm these predictions. An EPA-sponsored project to obtain experimental data is discussed and the test facility is described.

34918 (EPA—600/9-78-004, pp 89-110) **Granular bed filter for particle collection at high temperature and pressure.** Yung, S. (Air Pollution Technology, Inc., San Diego, CA); Parker, R.D.; Patterson, R.G.; Calvert, S.; Drehmel, D.C. 1977.

From EPA/ERDA symposium on high temperature/pressure particulate control; Washington, DC, USA (20 Sep 1977).

In EPA/DOE symposium on high temperature high pressure particulate control.

An evaluation of particulate control using granular bed filters is presented. Data and design models for collection efficiency and pressure drop are presented. This information was obtained from the literature, available performance data, and in-house experiments. The experimental program considered particles in the 0.1 to 5 μm size range. The penetration of monodisperse aerosols through the granular bed is determined with an optical particle counter. The effect of filter cake on performance is discussed. Applications for particulate removal from high temperature and pressure gas streams are emphasized.

34919 (EPA—600/9-78-004, pp 111-131) **Evaluation of a granular bed filter for particulate control in fluidized bed combustion.** Hoke, R.C.; Gregory, M.W. (Exxon Research and Engineering Co., Linden, NJ). 1977.

From EPA/ERDA symposium on high temperature/pressure particulate control; Washington, DC, USA (20 Sep 1977).

In EPA/DOE symposium on high temperature high pressure particulate control.

A program is underway to evaluate the use of a granular bed filter to reduce emissions of particulates in the flue gas from pressurized fluidized bed coal combustion. Since the filtered flue gas is to be expanded through a gas turbine, the emissions should be a level satisfying both the turbine and environmental requirements. Initial tests were terminated due to plugging of inlet screens by the particulates. The filter system was modified and further tests were more successful. A 24 hour run was completed and in this and other tests, the ability of the system to remove and collect particulates and maintain the pressure drops was demonstrated. However, the filter outlet particulate concentration is still slightly above the upper limit of the tentative target range set by gas turbine requirements. The current program is aimed at resolving these problems. Tests are now underway using dense filter media with no retaining screens and employing various filter cleaning cycle conditions. The objective of these studies is to increase the filtration efficiency further and to prevent the drop in efficiency with time. If current tests are successful, extended testing of the system will begin, coupled with a gas turbine materials test program. Environmental assessment tests will also be made.

34920 (EPA—600/9-78-004, pp 133-191) **Performance and modeling of moving granular bed filters.** Wade, G.L. (Combustion Power Co., Inc., Menlo Park, CA). 1977.

From EPA/ERDA symposium on high temperature/pressure particulate control; Washington, DC, USA (20 Sep 1977).

In EPA/DOE symposium on high temperature high pressure particulate control.

An ongoing experimental and theoretical effort sponsored by ERDA on moving granular-bed filters is described. Test apparatus includes a flexible cold-flow facility featuring a 3500-cfm filter where a parametric test program is in progress. The test facility is described along with the completed and planned variations in operating conditions and configuration geometry. Initial data on measured collection efficiency and pressure drop are presented; regression analysis indicates that reasonable operating conditions may be specified for which total efficiency in excess of 95% is readily attainable. A parallel mathematical-modeling effort is discussed, and key features of the resulting computer simulation program are identified.

34921 (EPA—600/9-78-004, pp 193-234) **Ceramic fabric filtration at high temperatures and pressures.** Shackleton, M.; Kennedy, J. (Acurex Corporation/Aerotherm Div., Mountain View, CA). 1977.

From EPA/ERDA symposium on high temperature/pressure particulate control; Washington, DC, USA (20 Sep 1977).

In EPA/DOE symposium on high temperature high pressure particulate control.

Barrier filtration using ceramic fiber filters offers a promising solution to the problem of controlling particles in the high-temperature, high-pressure environment. Industrial experience has proven this technique is capable of high efficiency particle control, including fine particles, in near ambient temperatures and pressures. Examining those particle removal mechanisms which apply to barrier filtration indicates that a small decrease in efficiency should be expected at high temperatures and pressures. This is primarily caused by a reduction in the effectiveness of the mechanism of inertial impaction. This reduction can be compensated for in the design of the filter medium and in the design of the filter system. Ceramic fibers are available which have smaller diameters (3 μm) than conventional fibers used for filters (10 to 20 μm). Analysis indicates that using these fine diameter fibers should make it possible to use filter media having weights less than or, at most, equal to conventional media. Work being performed to demonstrate the feasibility of high-temperature, high-pressure particle control by filtration is reported. A description of the high-temperature and pressure media test facility is presented along with test results to date.

34922 (EPA—600/9-78-004, pp 235-247) **High temperature fine particle control using ceramic filters.** Drehmel, D.C. (Environmental Protecion Agency, Research Triangle Park, NC); Ciliberti, D.F. 1977.

From EPA/ERDA symposium on high temperature/pressure particulate control; Washington, DC, USA (20 Sep 1977).

In EPA/DOE symposium on high temperature high pressure particulate control.

The technical and economic feasibility of using a porous ceramic filter for fine particle control in advanced power systems such as combined-cycle power plants with coal gasification were studied. The theory of Brownian deposition of particles in gas flows, and experimental procedures and results are discussed. Tests using the 3M ThermaComb as a filtering media were conducted at temperatures from ambient to 970°K. Filtering efficiency was found to be close to 100% even though the test dust had a mass median diameter of 1.4 μm and a significant fraction of sub micron material. Cleanability of the media was verified in experiments evaluating the effect of cleaning pulse intensity and duration. It was determined that the ceramic filter behaved similarly to fabric filters in that the pressure drop could be attributed to a residual pressure drop and that across an incompressible cake.

34923 (EPA—600/9-78-004, pp 249-277) **Problems of gas purification occurring in the use of new technologies for power generation.** Weber, E. (Univ., Essen). 1977.

From EPA/ERDA symposium on high temperature/pressure particulate control; Washington, DC, USA (20 Sep 1977).

In EPA/DOE symposium on high temperature high pressure particulate control.

The optimum use of new coal conversion technologies for power generation requires the development of suitable gas purification systems at high temperatures and high pressures. It has been shown that in principle scrubbing processes are suitable. The separation of solids should also be feasible with electrostatic precipitators and fabric filters while gravity and momentum separators are not of interest because of their low efficiency. It can be expected that in about 2 to 3 years the first gas purification system operating at high temperatures and pressures will be employed on a technical scale.

34924 (EPA—600/9-78-004, pp 281-308) **High temperature, high pressure electrostatic precipitation.** Feldman, P.F.; Bush, J.; Robinson, M. (Research-Cottrell, Inc., Bound Brook, NJ). 1977.

From EPA/ERDA symposium on high temperature/pressure particulate control; Washington, DC, USA (20 Sep 1977).

In EPA/DOE symposium on high temperature high pressure particulate control.

Work was undertaken to demonstrate the ability to generate stable corona at temperatures to 2000°F and pressures to 500 psig, thus establishing the feasibility of electrostatic precipitation as a means of particulate removal from the effluent of fluidized bed combustors or coal gasifiers at high temperature and pressure. Stable corona generation was demonstrated and ranges of temperature and pressure over which the stable discharge can be maintained were defined. The gases investigated were air, flue gas, and simulated (noncombustible) fuel gas in coaxial wire-pipe electrodes. Pipe diameter was fixed at 3 inches; wire diameter varied from 0.062 to 0.125 inches. Results are reported for both polarities in terms of current-voltage characteristics, corona onset and sparkover voltages, and critical gas densities above which sparkover alone, without antecedent corona, occurs.

34925 (EPA—600/9-78-004, pp 309-323) **Pulse-jet acoustic dust conditioning in high temperature/pressure applications.** Scott, D.S. (Univ. of Toronto); Swift, W.M.; Vogel, G.J. 1977.

From EPA/ERDA symposium on high temperature/pressure particulate control; Washington, DC, USA (20 Sep 1977).

In EPA/DOE symposium on high temperature high pressure particulate control.

The results of a completed investigation of pulse-jet acoustic dust conditioning (PJ-ADC) at conventional gas cleaning temperatures and pressures are reviewed with emphasis on how these performance characteristics might reasonably be extrapolated to high temperature/pressure operation. These arguments indicate that PJ-ADC at high pressure/temperatures might be more effective than at more conventional conditions. On this basis, a planned experimental program to evaluate PJ-ADC upstream of high efficiency cyclones in the pressurized fluidized-bed combustion (PFBC) process development unit (PDU) at the Argonne National Laboratory, is described. Two promising features of PJ-ADC in this application are: (1) the heat of PJ combustion contributes to the PFBC heat, and (2) the PJ should operate more effectively at elevated pressures.

34926 (EPA—600/9-78-004, pp 325-353) **Application of sonic agglomeration for the control of particulate emission.** Shaw, D.T.; Wegrzyn, J. (State Univ. of New York, Buffalo). 1977.

From EPA/ERDA symposium on high temperature/pressure particulate control; Washington, DC, USA (20 Sep 1977).

In EPA/DOE symposium on high temperature high pressure particulate control.

The feasibility of using acoustic agglomeration for particulate emission control in industry is evaluated. The dependence of the agglomeration time, which determines the agglomerator size, on various parameters--such as the mass loading, particle geometric mean diameter and standard deviation, acoustic frequency and intensity--is analyzed. Two agglomeration mechanisms are included: the inertial capture and the hydrodynamic collision. Based on the estimated agglomerator size and the specific energy consumption, possible applications of the acoustic agglomerator in industry is discussed, with special emphasis on the possible use of such a device in an environment in which the combined effects of high-pressure, temperature and chemical corrosion make it difficult to use the conventional devices.

34927 (EPA—600/9-78-004, pp 355-398) **Cyclocentrifuge development for particulate. Phase I. Feasibility study.** McCabe, J.T. (Mechanical Technology Inc., Latham, NY). 1977.

From EPA/ERDA symposium on high temperature/pressure particulate control; Washington, DC, USA (20 Sep 1977).

In EPA/DOE symposium on high temperature high pressure particulate control.

Gas cleanup was determined to be an area in which the special characteristics of a modified centrifuge offered technical and economic advantages over existing approaches. A new concept, called a cyclocentrifuge, was evolved during an analytical study in which the desirable characteristics of a cyclone and a centrifuge were combined in a compact design capable of separating fine particulate matter from hot pressurized gas at large flow rates on a continuous basis. A design example is given which shows the cyclocentrifuge to be capable of achieving a purity of 1 ppm of solids with a nominal maximum particulate diameter of one micron when processing 125,000 scfm of low Btu fuel from a coal gasifier.

34928 (EPA—600/9-78-004, pp 399-414) **Fine particle collection efficiency in the A.P.T. dry scrubber.** Calvert, S. (Air Pollution Technology, Inc., San Diego, CA); Patterson, R.G.; Drehmel, D.C. 1977.

From EPA/ERDA symposium on high temperature/pressure particulate control; Washington, DC, USA (20 Sep 1977).

In EPA/DOE symposium on high temperature high pressure particulate control.

The Particle-by-Particle (PxP) scrubber is a device which can be used at high temperature and pressure for the collection of fine particles on larger particles, which can be cleaned and recycled. Particle collection is mainly by inertial impaction and to some extent by diffusion for smaller particles. Experimental data on particle collection are in agreement with a mathematical model.

34929 (EPA—600/9-78-004, pp 415-428) **Hot gas clean-up by particle entrainment in coal slag based glasses.** McCreight, L.R.; Gatti, A.; Rauch, H.W.; Noone, M.J. (General Electric Co., Philadelphia). 1977.

From EPA/ERDA symposium on high temperature/pressure particulate control; Washington, DC, USA (20 Sep 1977).

In EPA/DOE symposium on high temperature high pressure particulate control.

An important problem in the utilization of gases from coal combustors to fuel gas turbines is the need to remove harmful particulates. For efficiency this must be done without appreciable cooling of the gases. Coal slag based glasses are being considered in an analogous manner to water scrubbers at normal ambient conditions for this purpose. Control of the viscosity by the use of both chemical and electrical energy additions is also included in the study to potentially permit operation over a temperature range of about 1000 to 1600°C. In this initial feasibility demonstration program, viscosity studies on various glasses including those made from fly ash and some model air cleaning studies are being performed in a clear plastic labyrinth unit using glycerine at room and low temperatures to simulate glasses. Later work will include high temperature studies and conceptual designs for a full sized system.

34930 (EPA—600/9-78-004, pp 429-463) **Molten salt scrubbing for removal of particles and sulfur from producer gas.** Moore, R.H.; Schiefelbein, G.F.; Stegen, G.E.; Ham, D.G. (Battelle Memorial Inst., Richland, WA). 1977.

From EPA/ERDA symposium on high temperature/pressure particulate control; Washington, DC, USA (20 Sep 1977).

In EPA/DOE symposium on high temperature high pressure particulate control.

Data are presented which shows 95 to 99% extraction of sulfur compounds from producer gas at 1250 to 1500°F has been achieved using a molten salt as the working fluid in a venturi scrubber. The salt was fully regenerable using excess steam + CO_2 to reverse the reaction. Efficient removal of particles was also achieved. Producer gas at a flow of 50 to 75 SCFM was generated in Battelle's fixed bed gasifier operating on metallurgical coke. These data together with earlier laboratory data have enabled design of a Process Demonstration Unit for operation in fully continuous mode. This PDU is in final phases of construction. The design basis and a few details of equipment are presented here.

34931 (EPA—600/9-78-004, pp 495-525) **Particulate sampling at high-temperature and high-pressure: the extractive approach.** Masters, W.Z. (Acurex Corporation/Aerotherm Div., Mountain View, CA). 1977.

From EPA/ERDA symposium on high temperature/pressure particulate control; Washington, DC, USA (20 Sep 1977).

In EPA/DOE symposium on high temperature high pressure particulate control.

A particulate sampler for high-temperature, high-pressure processes has been developed and successfully demonstrated. The system uses an extractive approach, removing samples from the process stream for complete analysis of particulate size distribution, morphology, and chemical composition. System capabilities have been demonstrated by sampling a pressurized fluidized bed combustor. The extractive sampling approach, the HTHP sampler design, and the data obtained from sampling operations are discussed.

34932 (EPA—600/9-78-004, pp 527-556) **Particle field diagnostic systems for high temperature pressure environments.** Trolinger, J.D.; Bachalo, W.D. (Spectron Development Labs., Inc., Costa Mesa, CA). 1977.

From EPA/ERDA symposium on high temperature/pressure particulate control; Washington, DC, USA (20 Sep 1977).

In EPA/DOE symposium on high temperature high pressure particulate control.

Particle diagnostic techniques and instrumentation are reviewed and their relative operational characteristics are discussed. A brief appraisal of optics techniques based on imaging and on light scattering methods has been given. The description of the principles of operation, applicability, and measuring characteristics of the instrumentation being developed by Spectron Development Laboratories (SDL) has been reviewed. These laser-based light scatter detection instruments are based on the predictable angular scattering characteristics of small particles and the interference of coherent light. Angular scattering intensity ratios are used for sizing particles in the range of 0.5 to 10 μm and particle sizing interferometry (visibility) is used in the range 2 to 100 μm.

34933 (EPA—600/9-78-004, pp 557-578) **On-line particulate analysis on a fluidized-bed combustor.** VanValkenburg, E.S.; Frock, H.N. (Leeds and Northrup Co., North Wales, PA). 1977.

From EPA/ERDA symposium on high temperature/pressure particulate control; Washington, DC, USA (20 Sep 1977).

In EPA/DOE symposium on high temperature high pressure particulate control.

An on-line particulate analysis instrument has been developed by Leeds and Northrup Company under ERDA sponsorship for monitoring particle loadings in the gas clean up stages of advanced combustion systems. This instrument utilizes low angle forward scattering of optically illuminated particles by across-the-duct measurements to determine their size and concentration. A prototype instrument has been designed and constructed to evaluate this means of measuring particles on fluidized bed combustion systems and field tests have been completed on this unit at the Argonne National Laboratory. A brief description of the instrument and results obtained from the Argonne tests are presented.

34934 **Selective removal of nitrogen oxides from waste gases.** Shiraishi, T.; Shimizu, S.; Shindo, T. (to Sumitomo Chemical Co., Ltd.). US Patent 4,075,283. 21 Feb 1978. Priority date 1 Feb 1974, Japan. 14p.

A process for the selective removal of nitrogen oxides from waste gases containing sulfur oxides as well as nitrogen oxides is described. The waste gases are contacted with a catalyst comprising active metal oxides consisting of vanadium oxide and at least one of molybdenum oxide and tungsten oxide as a catalytically active component and α-alumina having a specific surface area of 0.3 to 12 m^2/g and a pore volume of 0.1 cm^3/g or more as a carrier. The atomic ratio of the vanadium, molybdenum, tungsten and aluminum contained in the carrier alumina is given. The catalyst works in the presence of ammonia of 0.3 to 4 mol on the basis of 1 mol of nitrogen oxides contained in the waste gases at a temperature of 150 to 700°C.

34935 **Selective removal of nitrogen oxides from waste gases using V—MO—W catalysts.** Shiraishi, T.; Shimizu, S.; Shindo, T. (to Sumitomo Chemical Co., Ltd.). US Patent 4,071,601. 31 Jan 1978. Priority date 6 Mar 1973, Japan. 10p.

A process for selective removal of nitrogen oxides from waste gases containing 1,500 ppM or less (gas volume) of nitrogen oxides is described. The waste gases are contacted with a metal oxide catalyst containing vanadium oxide and at least one of molybdenum oxide and tungsten oxide with an atomic ratio of the oxide forming elements of: V/sub 12-x-y/Mo/sub x/W/sub y/ wherein $0 < \text{or} = \text{to } x < \text{or} = \text{to } 8$, $0 < \text{or} = \text{to } y < \text{or} = \text{to } 5$ and $0.3 < \text{or} = \text{to } x + y < \text{or} = \text{to } 8$, at a temperature of 150° to 700°C in the presence of 0.3 to 4 mol of ammonia (on the basis of 1 mol of the nitrogen oxides).

34936 **Removal of nitrogen and sulfur oxides from waste gases.** Kutepova, A.I.; Lur'e, B.I.; Artemenko, G.P.; Prozorova, R.G.; Mezentseva, L.P.; Naiko, L.I. *Int. Chem. Eng.;* **18**: No. 1, 118-120(Jan 1978).

Translated from Khim. Prom-st.; 18: No. 2, 50-52(1976).

An experimental study was made of the effect of temperature, space velocity, and pH value on the removal of sulfur dioxide and nitrogen oxides from gas streams by absorption in aqueous solutions of ammonium sulfite and bisulfite. An analysis of these data indicated that the use of a solution of ammonium sulfite and bisulfite with a pH = 8 is effective for the purification of complex gaseous mitures containing oxides of nitrogen and sulfur. The degree of removal of nitrogen oxides here amounts to 80%, while that for sulfur dioxide is 100%. Reducing the temperature of the absorptive solution has no influence on reduction of the degree of removal of nitrogen oxides from the gases. No nitrous oxide was observed in the chromatographic analysis of the gases after purification, which confirms the validity of the assumption regarding the reduction of the nitrogen oxides to elementary nitrogen.

34937 **Removal of carbon monoxide from gaseous mixtures.** Tatarenkova, I.A.; Leites, I.L.; Butov, V.V.; Turshu, S.M.; Semenov, V.P. *Int. Chem. Eng.;* **18**: No. 1, 120-125(Jan 1978).

Translated from Khim. Prom-st.; 18: No. 2, 46-50(1976).

An experimental study was made of the low-temperature removal of carbon monoxide from its gaseous mixture with nitrogen and hydrogen by absorption with condensing liquid nitrogen, confirming the validity of using Henry's law coefficients in design calculations for this process. The results of the investigation are in good agreement with the computed data and show the possibility of removing carbon dioxide from a gas with liquid nitrogen without using the nitrogen obained in air separation units, and with the simultaneous production of a mixture of nitrogen and hydrogen of the desired composition.

34938 **Technical-economic measures to reduce SO_2 emissions in the production of electricity.** Schwarz, O. (VGB Technische Vereinigung der Grosskraftwerksbetreiber e.V., Essen (Germany, F.R.)). *VGB Kraftwerkstech.;* **57**: No. 11, 722-725(Nov 1977). (In German).

From Power stations: aims of environmental protection and their realisation; Aachen, Germany, F.R. (27 - 28 Sep 1977).

The reduction of SO_2 emissions from the furnaces of new hard coal fired power stations is more a political than a technical requirement or one motivated by health considerations. It will have effects on electricity generation costs and therefore also on the prices of our industrial products which have to compete with products in the world market, which do not carry such an added burden, at least not yet. No power station operator opposes protection of the environment, in so far as this is economically viable. The paper refers to the consequences of political requirements and the technical measures taken but equally gives weight to the tasks of the power station operator, such as his statutory duty to make electricity available securely, economically and in sufficient quantity.

34939 **Mechanics of a turbulent contact absorber.** Uchida, S.; Chang, C.S.; Wen, C.Y. (West Virginia Univ., Morgantown). *Can. J. Chem. Eng.;* **55**: No. 4, 392-396(Aug 1977).

The turbulent contact absorber (TCA) has been recognized as one of today's best gas-liquid contacting devices. In recent months, scrubbing of stack gases by a lime or a limestone slurry in a TCA has proven to be a reliable and effective method for the removal of sulfur dioxide in order to meet air emission regulations. The operating conditions of a TCA can be divided into four regimes. The characteristic behavior of a TCA in each of the regimes is discussed. The condition below the flooding point is the usual operating regime. Correlations are developed to relate the pressure drop and the liquid holdup of a TCA by the operating variables. A terminal velocity model is developed to explain the flooding condition of a TCA. With this model, the hydrodynamic behavior of the TCA at the flooding point can be identified. The total pressure drop and the pressure drop across a single stage are distinguished to clarify the controversy whether the gas velocity can affect the pressure drop of a TCA. The total pressure drop of a TCA is composed of the pressure drop due to distributor loss at the entrance and the pressure drop of the bed itself. The pressure drop of a single stage bed of a TCA is independent of gas velocity.

34940 **Automatic boiler combustion control using excess oxygen measurements.** Wort, R.P. (CEGB, N.E. Reg, Engl). *Brown Boveri Rev.;* **64**: No. 7, 414-419(Jul 1977).

One of the basic instrument problems, as with many power stations, is the reliable determination of the excess oxygen present in the flue gases. Since this measurement is one of the most accurate ways of determining the combustion conditions within the boiler, unreliable readings result in poor indication and control of the boiler combustion. This article sets out the experience gained at Eggborough power station using excess oxygen measurements to control the combustion efficiency of 500 MW pulverized fuel boilers. In particular, it deals with the original design concepts of the control scheme and the use of zirconia oxygen probes to improve determination and control of combustion conditions.

34941 **Problem of determining nitrogen oxides.** Gorbanenko, A.D.; Krutiev, V.A. *Therm. Eng. (USSR) (Engl. Transl.);* **24**: No. 2, 68-69(1977).

Translated from Teploenergetika; 24: No. 2, 74-75(1977).

In connection with the increased emission of noxious substances into the atmosphere by power stations, the methods of sampling flue gases and of determining the concentrations of toxic nitrogen oxides in them become very important. To check the various materials used in the samplers, tests were conducted on a rig the combustor of which was of quartz glass. Gas samples were taken after the combustor or after the cooler which cooled the combustion products. Various samplers were tested: noncooled samples of carbon steel and stainless steel, and of quartz glass; samplers cooled by water, of stainless steel, brass and quartz glass. It was found that for sampling flue gases from the convective passes of boilers to determine NO/sub x/, one can use noncooled samplers of stainless or carbon steel with temperatures of the gases at the sampling point t/sub g/ $\leqq$ 700 to 750°C. At t/sub g/ $\leqq$ 900 to 950°C, onee can use noncooled stainless steel samplers. When sampling combustion products from the flame zone watercooled samplers must be used.

34942 Investigation of the effect of the burner excess air factor on the formation of hydrogen sulphide when burning anthracite. Ivanova, I.P.; Kaminskii, V.P.; Svistunova, L.A.; Mescheryakov, V.G. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 4, 13-16(1976).

Translated from Teploenergetika; 23: No. 4, 19-23(1976).

The formation of H_2S in the furnace of a boiler when burning pulverized anthracite in vortex type burners takes place not only in the wall-adjacent zone but also within the volume of the flame, from which it is carried by the p.f./gas flow sweeping the side waterwall. The formation of H_2S in the flame depends on the excess air factor of the burner. Apart from the excess air factor, a considerable influence on the formation of H_2S and its being carried to the side waterwall of the furnace is exerted by the aerodynamics of the flame. Introducing tertiary air in special peripheral channels of the vortex burners and increasing the proportion of the secondary air to the burners of the first row by redistributing it between the rows in the TPP-110 boiler got rid of the reducing medium in the wall-adjacent zone. A further effect is also exerted by the inclination of the burners towards the center of furnaces with front or opposed firing burners. Attention must be paid to ensuring uniform and optimal distribution of p.f. and air to the burners and a stable supply by the p.f. feeder since, even with optimal total excess air leaving the furnace there can be disparity between the excess air factors of different burners, which is particularly dangerous in relation to corrosion for the end burners.

34943 Chimneys of high reliability. Sapozhnikov, F.V.; Rikhter, L.A.; Volkov, E.P.; Gavrilov, E.I.; Skvortsov, A.P.; Lebedev, V.G. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 6, 39-45(1976).

Translated from Teploenergetika; 23: No. 6, 43-49(1976).

On the basis of an aerodynamic design, a highly reliable chimney was constructed with a gas flue of a new design with good aerodynamic characteristics. The chimney may be constructed by an industrial method, which results in considerable reduction of time for erection of the chimney and in considerable economic advantages. In construction of a chimney, 22,000 man-days were saved, and the time for construction was reduced by 10 months as compared with a chimney with an acid-resisting lining. The problem regarding extensive construction of chimneys with silicon concrete gas flues can be solved after thorough analysis of the results under conditions of long continuous operation of the first chimneys of this design. After four months' and after one year's service, the chimney was inspected by a special commission (in 1973 and 1974). The gas flue was inspected outside and inside. On the whole the state of the silicon concrete panels was satisfactory. Thus, at present the experience with employment of silicon concrete for the flue has produced good results.

34944 Effect of temperature and aerodynamic factors on the formation of sulphur trioxide in a furnance chamber. Pomerantsev, V.V.; Podolyak, V.E.; Moiseeva, T.A.; Katsman, V.I.; Karpov, V.V.; Vyazovoi, S.K.; Burkhanov, D.V. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 8, 29-32(1976).

Translated from Teploenergetika; 23: No. 8, 46-49(1976).

The amount of sulfur trioxide present at the end of a furnace is influenced, apart from the sulfur content of the fuel, by the excess air factor, the temperature in the core of the flame, and largely by the rate of cooling of the flame. In view of the complexity of investigating the processes of formation and dissociation of sulfur trioxide in a three-dimensional flame, an analysis is given of the factors which affect the amount of SO_3 formed for a two-dimensional flame. The temperature and aerodynamic features of various furnace chambers, operational conditions, etc. are taken into account.

34945 Means of decreasing air pollution in towns by fuel combustion products. Styrikovich, M.A.; Minaev, E.V.; Troitskii, A.A.; Vnukov, A.K. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 9, 30-36(1976).

Translated from Teploenergetika; 23: No. 9, 26-32(1976).

The main sources of pollution of city air by CO, SO_2 and NO_2 are stationary and mobile plants consuming fossil fuel for power generting and manufacturing purposes. The participation of individual sources and of branches of industry in the formation of the general background of pollutant concentration in the air of the city is not directly related to the mass of pollutant emissions by these sources. In particular, for the considered city the power stations and heating plants contribute only a few percent of the average background with respect to SO_2 and NO_2 and take virtually no part in the formation of the background CO. The effectiveness of equal investments in gas cleaning in the different branches of the municipal economy with regard to improving the general background of city air pollution can differ by a very great amount. In this connection the planning of measures for reducing the background should be carried out by means of interdepartmental optimization of sizes and distribution of investment between plants. Figures are given and the procedures are used of an evaluating nature are regarded as initial premises for the formulation of appropriate detailed investigations.

34946 Efficiency of straight-through cyclones. Matsnev, V.V.; Ushakov, S.G. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 9, 64-66(1976).

Translated from Teploenergetika; 23: No. 9, 80-82(1976).

Aerodynamic measurements of the flow in straight-through cyclones 500 mm and 2600 mm in diameter have made it possible to establish the absence of self-similarity of the flow in units of widely differing dimensions. A reduction in the average frequency and an increase in the average scale of the turbulence in large-diameter cyclones were demonstrated. These factors affect the efficiency of dust removal, especially for fine particles. A generalized critical dependence was obtained for calculation of the grade efficiency of straight-through cyclones of differing diameter, and its zone of application was determined.

POWER TRANSMISSION AND DISTRIBUTION

REFER ALSO TO CITATION(S) 35908

34947 Interactive design of electricity networks using spare-capacity reinforcement algorithms. Wilde, R.J.; Boardman, J.T. (Brighton Polytechnic, Eng.). *Proc. Inst. Electr. Eng. (London);* **124**: No. 9, 757-762(Sep 1977).

A sophisticated visually interactive computer-aided design (c.a.d.) system is described for electricity distribution networks. An original spare-capacity model and an automatic network reinforcement algorithm are presented. These were incorporated in the c.a.d. system, thereby providing a comprehensive network performance assessment of the simulation.

34948 Research and development. Harlow, J.G. Jr. (Oklahoma Gas and Electric Co., Oklahoma City). *Electr. Power Syst. Res.;* **1**: No. 1, 1-7(Sep 1977).

The need for increased research and development programs to provide technological advances to meet future energy demands, particularly electric power demands, is discussed. It is concluded that the future energy needs of the world can only be supplied through technological improvements. The cost of these technological improvements can be minimized by cooperative, unified research and development programs. The financial support of the energy industry, the equipment manufacturing industry and the consumer will be required to finance these vital developments. The energy problems of the world can be solved by an adequately financed unified R and D effort. The U.S. must assume a major role of leadership in this world-wide effort. (LCL)

34949 Losses in electrical power systems. Chen, M.S. (Univ. of Texas, Arlington); Ohba, Y.; Reynolds, L.; Dickson, W.D. *Electr. Power Syst. Res.;* **1**: No. 1, 9-19(Sep 1977).

Losses in an electric power system are discussed. Methods for evaluation of losses in generation, transmission, distribution and consumption are introduced. An understanding of the power system losses is important not only to the power system engineer but also to the energy policy maker.

34950 Damper vibration attenuation for overhead lines. Bouche, R.R. (Bouche Labs., Sun Valley, CA). *Electr. Power Syst. Res.;* **1**: No. 1, 59-65(Sep 1977).

Structural impedance measurements are useful for determining the characteristics of vibration dampers. Earlier theoretical work demonstrated how impedance or dynamic mass measurements could be used to determine the vibration attenuation achieved at the damper end of a transmission line span. Now the theory is extended to determine vibration attenuation at all points in the span. For example, the vibration attenuation can be determined at mid-span, at the end of the span at which a damper is installed and at the undamped end of the span. The theory could be used to predict vibration attenuation by making dynamic mass measurements on the conductor at points of interest and combining the results with dynamic mass measurements on dampers. However, the vibration attenuation achieved at both ends of the span is more simply determined from vibration amplitude measurements made with and without the damper installed. The results provide a simple means for evaluating the vibration attenuation characteristics of dampers.

34951 Secondary analysis functions of the new real time system of E.D.F. power control center (SYSDIC project). Merlin, A. (Electr de Fr). *Bull. Dir. Etud. Rech., Ser. B;* No. 1, 33-46(1977).

The aim of this paper is to present all the functions of secondary analysis which will be implemented on the future real time system of national control center of Electricite de France (SYSDIC project). These functions are distributed into two distinct classes which are: real time secondary analysis; extended real time secondary analysis. Each of these functions are briefly analysed, insisting in particular on the real time functions. French.

34952 Device and method for the fabrication and laying of submarine cables. Francisco-Arnold, R. German(FRG) Patent 2,610,799/A/. 7 Oct 1976. 25p. (In German).

6 figs.

For the production and laying of seamless underwater cables of indefinite length it is proposed to produce the cables from suitable raw materials on the ship itself. The method aims in particular at cable or pipe laying by the underwater floating method.

AC SYSTEMS, EHV AND UHV

34953 (CONF-780301—1) **Dielectric strengths of new gases and gas mixtures.** James, D.R.; Christophorou, L.G.; Pai, R.Y.; Pace, M.O.; Mathis, R.A.; Sauers, I.; Chan, C.C. (Oak Ridge National Lab., Tenn. (USA); Tennessee Univ., Knoxville (USA)). 1978. Contract W-7405-ENG-26. 28p. Dep. NTIS, PC A03/MF A01.

From International conference on gaseous dielectrics; Knoxville, TN, USA (6 Mar 1978).

It is emphasized that the most effective gaseous dielectrics are gas mixtures with components chosen on the basis of fundamental physicochemical knowledge, especially on low-energy electron-molecule interactions. On the basis of such lnowledge, especially on electron attachment and electron slowing down, a number of new gases and gas mixtures have been found with breakdown strengths superior to pure SF_6. These include the unitary gases c-C_4F_8 (perfluorocyclobutane), C_4F_8 (perfluorobutene-2), C_4F_6 (perfluoro-2-butyne), C_6F_{10} (perfluorocyclohexene), C_5F_8 (perfluorocyclopentene), and C_6F_{12} (perfluorodimethylcyclobutane), and the multicomponent gas mixtures 20% C_4F_6 + 80% SF_6, 40% C_4F_6 + 60% N_2, 50% C_4F_6 + 50% SF_6, and 30% C_4F_6 + 20% SF_6 + 50% N_2 with DC breakdown strengths relative to SF_6 of 1 equal to 1.4, 1.8, 2.2, 2.1, 2.2, 2,4, 1.3, 1.4, 1.75, and 1.33, respectively. Findings on these and other systems are presented and discussed. Also discussed are results on the dielectric strengths of some of the above new gases measured with cylindrical electrode geometries using different center conductor diameters. Finally, findings on the initial decomposition products of some of the new insulators caused by electron impact are presented and their implications assessed.

34954 Toshiba's newly developed phase comparison relaying system for transmission line protection. Muraoka, M.; Suzuki, S.; Tsukui, R. *Toshiba Rev., Int. Ed.;* No. 113, 6-11(1978).

The necessity for high reliability in the protective relaying system is growing ever stronger. Toshiba supplies many carrier pilot relaying systems that protect power transmission lines at high speed and with high sensitivity. The phase comparison relaying system described is one of these systems. It is also one of the most advanced systems with many markedly improved functions. Accordingly, it is widely used for the protection of directly grounded systems. This system, composed of static components, has a supervising and automatic checking system in itself to achieve high reliability in the field. The characteristics of the summation current transformers for the one and a half circuit breaker system and duplicated system are also described.

34955 Modern and future cables for high-power transmission. Huebner, R. *Elektr. Energ. Tech.;* **22**: No. 5, 237-241(Oct 1977). (In German).

First, the construction of conventional high-power cables with natural cooling is described. Limiting loads for three-phase current cables are given. This limiting load may be increased by forced cooling with water or oil. Cables with different types of forced cooling are discussed; their limiting loads are listed in cables.

34956 Electric power transmission problems. Angelini, A.M. (Ente Naz per l'Energ Elettr, Italy). *Elettrotecnica;* **64**: No. 9, vp.(Sep 1977). (In Italian).

After a few general remarks on the transfer of energy, including fossil fuel, the most important problems relating to UHV, dc and ac of electric power transmission are considered. Some of the most interesting achievements in the field of d.c. power transmission are recalled and reference to the main UHV research projects of the present day. An examination is made of problems associated with the structure of the substations and lines, taking into account technical, economic and environmental questions. After a few comments on the advantages of large interconnected systems, the interconnnection principles of the European power system are considered, and mention is made of the international organizations coordinating activities in this field. In conclusion the importance of a centralized control system to achieve economy and efficiency in the operation of electric power production and exchange in a largely interconnected, international system is pointed out.

34957 Current-limiting device utilizing a switched resistor. King, H.J.; Knauer, W. (Hughes Research Labs., Malibu, CA). *Electr. Power Syst. Res.;* **1**: No. 1, 51-57(Sep 1977).

One method of minimizing the effects of faults on a power transmission system is to rapidly insert a resistor in series with the faulted line or with an adjacent feeder line supplying current to the fault. In order to limit the peak momentary current, this resistor insertion must take place in a fraction of a cycle--typically in one millisecond. A current-limiting device of this type has been designed and constructed to operate in series with a 150 MVA feeder transformer supplying power to a 138 kV bus. The switching mechanism is a rotary mechanical switch in parallel with a cold cathode glow discharge tube. The latter device is capable of interrupting kiloampere DC currents, thus permitting current interruption at any point on the AC wave.

34958 Application of current limiting to distribution circuit protection. Popeck, C.A.; Lewis, W.A.; Allen, G.D. (A.B. Chance Co., Centralia, MO). *Electr. Power Syst. Res.;* **1**: No. 1, 67-86(Sep 1977).

Many electric utility systems are reaching the point where available short-circuit currents, during severe faults, exceed the interrupting capability of available circuit interrupters of conventional types such as circuit breakers, distribution-circuit reclosers, and expulsion fuses. The needs are being met by the use of current-limiting fuses to protect individual distribution transformers or, sometimes, groups of distribution transformers, but there are difficult problems of coordination. The current-limiting fuses are not inherently capable of covering the full range of short-circuit currents, so that they must be used in addition to, or in combination with, interrupters of other types. These problems are studied in depth and recommendations are made for even wider use of current-limiting fuses to achieve more effective protection of the entire distribution system, including protection of distribution feeders at the substation. This approach also provides effective preventive measures to inhibit disruptive transformer failures which have become a severe problem with increasing short-circuit-current capability.

34959 Evaluation of hygienic norms beneath super high voltage power transmission lines. Ivanova, S.N.; Goncharik, E.P. *Izv. Vyssh. Uchebn. Zaved., Energ.;* No. 8, 118-121(Aug 1977).

In order to establish the effect of the high voltage electric fields existing beneath power lines on operating personnel, a series of experiments was performed beneath overhead lines at 330 kV substations and the results of experiments beneath the 750 kV power line between Konakov and Moscow were used. The current flowing from a man standing vertically with his hands at his sides was measured by a shielded microammeter which was grounded, the subject standing on an insulator. As a result, an empirical relationship was determined between the electric field intensity at the level of the height of a man and the current induced by this field in the body of a man standing on the ground: $I/E = h/9—7.34\ \mu A/kV/m$ where I is the current flowing through the subject, E is the electric field intensity, h is the height of the man in cm. Thus, if a meter is not available to measure directly the electric field intensity, a microammeter can be used to measure the current flowing from a man standing under the line to ground, and thus the field intensity can be estimated.

34960 Automatic calculation of grounding installations of any complexity in double-layer homogeneous and nonhomogeneous soils. first results of a systematic investigation of dispersers for hv/mv stations and mv/lv substations. Buccheri, P.; Cataliotti, V.; Morana, G. (Univ di Palermo, Italy). *Energ. Elettr.;* **54**: No. 6, 293-304(Jun 1977). (In Italian).

A new method is presented which makes it possible to determine, by means of a computer, the total resistance as well as pitch and contact voltages of a complex grounding net in double-layer homogeneous and nonhomogeneous soils. The proposed method makes it possible to describe in a synthetic and unequivocal way grounding net of any shape (with or without symmetry character and random oriented disperses) and gives rise to a calculation program that offers a very wide possibility of use as it is not bound to particular shapes of the dispersers, nor is restricted exclusively to homogeneous grounds and symmetric structures. The program has been applied for a symmetric study of dispersers of large and small size, for HV/MV stations and MV/LV substations having some typical structures that ENEL plans to adopt for a national-wide standardization. This paper illustrates the proposed method with the additions suggested by the experience. The first results of the research so far carried out are given. 11 refs.

34961 Sizing of magnetic shielding in high-capacity transformers. calculation by means of the finite element method. Di Napoli, A.; Paggi, R. (Univ di Roma, Italy). *Energ. Elettr.;* **54**: No. 7/8, 355-365(1977). (In Italian).

This paper, using the Finite Element Method, discusses the shielding of magnetic flux in transformers, for the correct sizing of the shieldings. A calculation program which performs the automatic construction of the lattice is worked out; this makes it possible to study in a short time the various types of shieldings and analyze the dispersed flux of any transformer, whatever the number of windings and their mutual position might be. The program thus set up makes it possible moreover to trace the maps of the magnetic field, directly Weber graduated. In this way the analysis of results is quicker, and it is possible to graphically represent a magnitude, index of the shield-

ing effectiveness, as a function of both thickness and position of shieldings.

34962 Functions of a large power transport and interconnection system. Clade, J. (Electr de Fr). *Rev. Gen. Electr.;* **86**: No. 7-8, 553-557(1977). (In French).

In spite of the apparent simplicity, the functions of a large electric network are multiple and complex. In a synthesis attempt the article summarizes these functions successively: basic technical functions, i.e., power transmission and disturbance compensation, economical function, interconnection function. It considers the load distribution and its incidence upon network planning and operation as well as the conditions of their stability. To conclude, it is recalled that, in spite of the rapidity of technical evolution and progress made, the planning, operation and handling problems of large systems still remain topical and give rise to numerous studies.

DC SYSTEMS

REFER ALSO TO CITATION(S) 34956, 34965

34963 (HCP/T2068—1) Contamination flashover mechanisms of dc transmission line insulators. Final report, September 1, 1975—August 31, 1977. (Massachusetts Inst. of Tech., Cambridge (USA)). Jan 1978. Contract EX-76-C-01-2068. 352p. Dep. NTIS, PC A16/MF A01.

A scaled contamination experiment modeling the electric field, air flow, and particle dynamics around an insulator string has been implemented. Outstanding contamination features shown explicable by simple trajectory models include sharp clean rings and leeward wakes on the insulator surfaces, and diffuse contamination bands on the pin caps. Large scale deflection of incident charged particles is shown to be unlikely, although segregation of attracted and repelled particles to lower and upper regions of the string is observed. A practical contamination model in which surface deposition is proportional to normal electric field multiplied by particle mobility is shown to be quantitatively valid. Positive polarity contamination flashover occurred at 25% higher voltage than negative for a planar insulator. Possible theoretical reasons for this were tested experimentally. The most likely reason is the current density difference between anode and cathode spots on the wet surface. Further work is needed to quantify this. High speed photography showed arc growth rates of several hundred cm/sec., and that current is a single valued function of arc length during the final stages of growth, greatly simplifying modelling. Computer modelling was done, but validation requires determination of some physical constants. Electrochemical effects were found to greatly influence the surface contaminant distribution, and hence the flashover voltage.

34964 Static compensator performance in long-distance transmission systems. Kaufhold, W.; Povh, D.; Tyll, H. (Siemens, Erlangen, Ger). *Siemens Forsch.- Entwicklungsber.;* **6**: No. 5, 286-292(1977). (In German).

Static compensators can be used for controlled parallel reactive power compensation in long-distance transmission systems; i.e. to compensate voltage fluctuations during steady-state operation, to reduce system overvoltages and to improve system stability. A high-voltage transmission system was simulated in detail on a TNA of Siemens AG to study the influence of different parameters of compensator control and the compensator performance on faults on the system. The differences between the performance of static compensators and rotating synchronous condensers were studied.

SUPERCONDUCTING AND CRYOGENIC SYSTEMS

REFER ALSO TO CITATION(S) 35302, 35796

34965 Bulk power transmission by superconducting dc cable. Chowdhuri, P.; Edeskuty, F.J. (Los Alamos Scientific Lab., NM). *Electr. Power Syst. Res.;* **1**: No. 1, 41-49(Sep 1977).

It is estimated that the total electric system load in the U.S.A. will increase five- to seven-fold by the year 2000. It is reasonable to assume that the transmission line capacities will also increase at least by the same amount. For energy conservation, future transmission lines must be more efficient than those of today. There will also be mounting public pressure to transmit electric power underground because of increasing awareness of environmental quality. There are considerable research activities to develop new technologies to transmit large blocks of power more efficiently by underground cables. The goal of the DC superconducting power transmission line (SPTL) program at the Los Alamos Scientific Laboratory is to develop such a cable. The DC SPTL has the advantage that it has very high power capability (10 GW and more) and no conductor or dielectric losses. The only "loss" of a DC SPTL is in the refrigeration requirement. It has no systems constraints, such as the stability or reactive compensation requirements of an AC system. The conceptual Los Alamos design, some of the technical problems associated with the development and the approaches to their solution are discussed.

34966 Optimization of helium refrigerators for superconducting power transmission lines in terms of cost and reliability. Kadi, F.J.; Longsworth, R.C. (Air Products and Chemicals, Inc., Allentown, PA). *J. Eng. Ind.;* **99**: No. 3, 551-557(Aug 1977).

Helium refrigerators for superconducting power transmission lines are optimized in terms of the minimum cost required to achieve a specified level of reliability. A summary is given of the cost and reliability of large helium refrigerator components as determined from a survey of existing refrigerators, compressor and expander studies, and an analysis of Air Products unattended standard nitrogen plants. These data are used to analyze the cost and reliability of several alternate refrigerator designs.

NUCLEAR POWER PLANTS

34967 Soil warming for utilization and dissipation of waste heat in Pennsylvania. DeWalle, D.R. (Pennsylvania State Univ., University Park); Chapura, A.M. Jr. *Nucl. Technol.;* **38**: No. 1, 83-89(Apr 1978).

The feasibility of using soil warming for utilization and dissipation of reject heat from power plants was demonstrated in a year-long test operation of a field prototype in Pennsylvania. A parallel network of 5-mm-diam polyethylene pipes was buried at a 0.3-m depth and with 0.6-m spacing in the soil covering a 15- x 60-m area to convey hot water simulating condenser cooling water from a power plant. Crop response to the heated soil varied: Snap beans and warm season forage crops such as sudangrass responded with increased yields, while cool season forage crops experienced decreased yields. Winter wheat yields were also increased, but winter barley was winter-killed due to delayed development of cold tolerance in the warm soil. Heat dissipation from the buried pipes was primarily by thermal conduction to the soil surface. Rates of heat loss from the buried pipes were most accurately predicted using an equation that included an explicit term for heat conduction below the pipes. Estimated soil warming land area necessary to dissipate all the reject heat from a 33% efficiency, 1500-MW electrical power plant based on minimum measured summer heat loss rates was 76 km^2 compared to the economic optimum of 18.2 km^2 determined as the least-cost system.

34968 Experience gained in France on heat recovery from nuclear plants for agriculture and pisciculture. Balligand, P. (Commissariat a l'Energie Atomique, Paris); Le Gouellec, P.; Dumont, M.; Grauby, A. *Nucl. Technol.;* **38**: No. 1, 90-96(Apr 1978).

Since 1972, the Commissariat a l'Energie Atomique, Electricite de France, and the French Ministry of Agriculture have jointly examined the possibility of using thermal wastes from nuclear power plants for the benefit of agricultural production. A new process to heat greenhouses with water at 303 K using a double-wall plastic mulching laid directly on the soil has been successfully used for a few years on several hectares. When necessary, heat pumps are utilized. Very good results have been obtained for tomatoes, cucumbers, flowers, and strawberries, etc. Outdoor soil heating with buried pipes has been tested in Cadarache near an experimental pressurized water reactor for market garden crops and forestry. Gains in precocity and yield have been excellent, especially for asparagus, strawberries, and potatoes. Growing of eels has been four times faster in warm water over one year.

34969 How operators are seeking to reduce outages. Roberts, A. (Dresen Nuclear Power Stations). *Nucl. Eng. Int.;* **22**: No. 264, 70(Nov 1977).

Comments are offered on some of the issues involved in efficient and reliable operation of nuclear power plants, a subject discussed at a recent NAS conference. The minimizing of outage time is of particular interest, the key to this being good planning. Mention is also made of the importance of scheduling of both work and and worker and the quality of operators.

34970 Westphalia power station. Kahlert, W. (Vereinigte Elektrizitaetswerke Westfalen A.G. (VEW), Dortmund (Germany, F.R.)). *VGB Kraftwerkstech.;* **57**: No. 11, 743-746(Nov 1977). (In German).

Westphalia Power Station has at present an installed capacity of about 670 MW based on hard coal. Two nuclear power station companies, the High-Temperature Nuclear Power Station Company (HKG) and the Hamm Nuclear Power Station Company (KKH), in which VEW participates, are erecting on the site of Westphalia Power Station two nuclear power stations with a capacity of 300 MW and 1,300 MW respectively. The spaciousness of the power station site, the favourable infrastructure and the possibility of a supply of cooling and feed water from the River Lippe and/or from

the canal permit further development of the power station site with coal-fired or nuclear power plant.

34971 Characteristics of the combined operation of thermal and fast power reactors. Litkin, V.B.; Kagramanyahn, V.S. *J. Br. Nucl. Energy Soc.;* **16**: No. 4, 335-339(Oct 1977).

From Operating experience with nuclear power stations and routes of future development of atomic power conference; Obninsk, USSR (25 - 27 Jun 1974).

Thermal reactors have several deficiencies, in particular, their low efficiency in the use of national uranium resources. The advantages of joint use of thermal and fast reactors in a nuclear power system are indicated. Current fast reactors assessments however, show higher specific capital costs than for thermal reactors. To determine the combination of both types for which the economic effect is a maximum, optimization calculations are necessary including optimization of reactor characteristics. Some of the problems involved are examined. Analysis of the results shows that in the period of mass introduction of fast reactors, thermal reactors of high plutonium production are required in the early stages and that the significance of expenditure on the initial fuel inventory in the cycle increases sharply in comparison with that for established fast reactors.

34972 Nuclear fuel cycle. Pt. 4. The reactors. Farmer, A.A. (UKAEA Reactor Group, Risley). *Arch. Energiewirtsch.;* **31**: No. 10, 843-858(Oct 1977). (In German).

The basic concepts of the reactor types now in commercial operation or to be realized before 1990 are described in the form of a survey. In the framework of a description of special features and differences, the typical parameters of the reactors are listed for comparison.

34973 Improvements in energy transforming engineering. Knizia, K.; Hirschfelder, G.; Schwarz, D.; Weinzierl, K. *Brennst.-Waerme-Kraft;* **29**: No. 9, 353-360(Sep 1977). (In German).

From 10. world energy conference. Availability and rational uses of energy resources; Istanbul, Turkey (19 - 24 Sep 1977).

The reduction of reserves of fossile primary energies, as well as of economically minable uranium ore, is enforcing the improvement of plant efficiencies and the introduction of new technologies, also in view of environment protection. In constructing conventional power stations, the application of the combined gas/steam turbine process has secured an optimal efficiency of the plant, as well as a favourable behaviour at part load. While the combined process has so far been restriced to the use of gaseous or liquid fuels, it can now be applied to solid fuels too, with the help of the coal gasification. The efficiency of such a plant with added coal gasification and gas purification is more favourable than that of a conventional coal-fired power station, including flue gas desulphurisation. For the construction of nuclear power stations or for further development of nuclear power stations, the problems of fuel utilisation and of safety will have to receive special attention. The development of sodium- or gas-cooled fast breeder reactors is necessary for extending the resources of uranium. The further development of the high-temperature reactor is offering-besides the advantage of a high efficiency - the possibility of making available process heat at a high temperature level for the purpose of coal gasification or district heating.

34974 Building up a reactor industry. A national and international task. Mattick, W. (Brown, Boveri und Cie A.G., Mannheim (Germany, F.R.)). *Atomwirtsch., Atomtech.;* **22**: No. 9, 471-477(Sep 1977). (In German).

From Reactor congress 1977; Mannheim, Germany, F.R. (29 Mar - 1 Apr 1977).

The reactor industry has in common with any other industry the need to meet a requirement in a specific market with a specific product. However, it is distinguished from old established industries by its origins, its young age and by the fact that most of its development costs were paid by the governments in all developed countries. A comparison of the origins and the history of companies in this field in the United Kingdom , France and the Federal Republic of Germany should merit special interest. A historical survey of this kind is presented in this contribution. If a technological project acquires international ramifications in order to diminish the market risk, national goals frequently must give way to a common objective. Problems involving practical application must be solved by joint efforts of industrial consortia. In this way, these industries can both offer a commercially viable product and take into account national characteristics or habits in such a way as to improve the overall cost-benefit situation with all parties involved.

34975 Requirements to be met by the operating manual. Koeln, Germany, F.R.; Heymanns (Jun 1977). 27p. (In German). (KTA—1201).

The rule draft applies to the contents and the lay-out of the operating manual for stationary nuclear power plants. The draft contains: 1. General requirements to be met by the contents of the operating manual. The operating manual to be arranged in 4 parts (part 1: internal rules and regulations; part 2: operation overall plant; part 3: incidents; part 4: operation systems). Safety specifications to be included in the manual, the exemption being the system of technical documentation. - 2. General requirements to be met by the lay-out of the operating manual. Comprehensibility; legibility; structure and subdivisions; arrangement of the instructions and design of the manuals cover. - 3. Requirements to be met by part 1. Defining the various internal rules and regulations (personnel management; rules and regulations concerning inspections and shift work; maintenance and repair; radiation protection; guard duty and admission; alarm; fire protection; first aid. - 4. Requirements to be met by part 2. Provisions and operational limitations; limit values important from the point of view of safety; normal operation; anomalous operation; in-service inspections. - 6. Requirements to be met by part 3. - 7. Annex: Rules, regulations and stipulations mentioned in the rule draft.

34976 Nuclear power industry, waiting for evolution of the administration. 17th survey report of the nuclear power industry. *Genshiryoku Chosa Jiho;* No. 30, 1-68(May 1977). (In Japanese).

Covering the proceeds, expenditures, personnel, etc. in nuclear power industry of Japan from April 1, 1975 to March 31, 1976, the 17th survey report by questionnaire to 1,238 enterprises (72.1% recovery) is presented. While the proceeds and sales have advanced significantly, the backlog is on the decrease; and, the personnel situation is active. Overall, a new evolution of the administrative measures is awaited. In the fiscal year, total expenditures are 761,800 million yen (1.17-fold from the previous year), proceeds in mining and manufacturing 354,100 million yen (1.27-fold), and personnel 34,640 (1.04-fold).

34977 Waste heat utilization in agriculture. Luckow, H. pp 324-328 of Abfallwirtschaft und Recycling. Probleme und Praxis. Keller, E. (ed.). Essen, Germany, F.R.; Girardet (1977). (In German)

The present contribution reports on the AGROTHERM development project, which is sponsored by the Federal Ministry for Science and Technology in Bonn. This project is an attempt at a non-polluting utilization of the 'thermal waste' (waste heat) of nuclear power plants by means of an underground pipeline system. The waste heat will be used to increase agricultural yields. By 1976, the pipeline systems had been installed at all test sites.

34978 Canadian Nuclear Association--annual international conference proceedings, 17, Volumes 1 through 6, 1977. Montreal; Canadian Nuclear Association (1977). 478p.

From 17. annual international conference of the Canadian Nuclear Association; Toronto, Ontario, Canada (5 Jun 1977).

This conference contains 18 papers, 82 extended abstracts, an address by the President of the Canadian Nuclear Association, and various CNA committee reports. The papers consist of progress reviews of Canadian reactors and nuclear research projects and discussions of energy policy, foreign nuclear stations, nuclear fuels and materials, and fusion power. The extended abstracts deal with environmental effects of nuclear development, seismic analysis of nuclear power plants, heat transfer, nuclear engineering, analytical methods, physics and mathematics, economic development of nuclear power, technological forecasting, heavy water, nuclear fuels, mechanical design, reactor control and instrumentation, and quality assurance. Selected papers are indexed separately. 6 refs.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED

REFER ALSO TO CITATION(S) 35119, 35121, 35136, 35238, 35256, 35260, 35267, 35271, 35279, 35280, 35288, 35545, 36329

34979 (BARC—884) **Fission product release behaviour after reactor shutdown: experience at Tarapur Atomic Power Station.** Narasimhan, S.V.; Venkateswaran, G.; Venkateswarlu, K.S. (Bhabha Atomic Research Centre, Bombay (India)). 1977. 18p. Dep. NTIS (US Sales Only), PC A02/MF A01.

A study on the fission product release behaviour after reactor shutdown has been carried out at Tarapur Atomic Power Station. The activity concentrations of iodines, caesium and technetium in reactor water have been measured. The release rates and release rate coefficients have been computed. The nature of the variation of the release rate coefficients with decay constants of the iodines has been used to find out the mechanism of their release. In this connection an interstation comparision has been made between Gundremmingen BWR in West Germany and TAPS BWR.

34980 (EPRI-NP—676-SR) **Detailed analysis of the fundamental ultrasonic response data from stainless steel stress corrosion crack specimens.** McElroy, J.T. (Southwest Research Inst., San Antonio,

Tex. (USA). Quality Assurance Systems and Engineering Div.). Feb 1978. 103p. Dep. NTIS, PC A06/MF A01.

After the Boiling Water Reactor (BWR) stress corrosion cracking incidents on 4- and 10-inch stainless steel piping, the Electric Power Research Institute (EPRI) organized a round-robin ultrasonic examination of piping removed from service. Five teams including Southwest Research Institute (SwRI) participated in this program, using both a standard procedure and the individual team procedure. The original intent was to section the piping after the program to evaluate the effectiveness of state-of-the-art ultrasonics to find stress corrosion cracking. This sectioning was delayed to allow SwRI engineers and other development groups time to perform basic measurements aimed at determining optimum search unit and instrument characteristics for the ultrasonic examination of stainless steel piping. During the study, the SwRI team collected approximately 400 data points. These data consist of oscilloscope recordings of the RF (radio frequency) waveform and a linear spectrum analysis of the signal reflected from the crack specimens. The report summarizes the ultrasonic response data compiled during the course of the study. The results of this study have indicated direction for remedial action.

34981 (EPRI-NP—717) **EPRI—NASA cooperative project on stress corrosion cracking of Zircaloys. Final report.** Cubicciotti, D.; Jones, R.L. (SRI International, Menlo Park, Calif. (USA)). Mar 1978. 265p. Dep. NTIS, PC A12/MF A01.

The results of research aimed at developing improved understanding of the stress corrosion cracking (SCC) mechanism considered responsible for pellet-cladding interaction (PCI) nuclear fuel failures are presented. PCI failures originate at the fuel side of the Zircaloy cladding, and therefore, the major objective was to define the SCC mechanism of Zircaloy in environments relevant to those at the inside surface of operating fuel cladding. The results of examinations of the inside surfaces of irradiated fuel cladding from two power reactors showed that Zircaloy cladding can be exposed during service to a number of potentially aggressive substances. Zircaloy samples were screened at reactor operating temperatures for susceptibility to SCC induced by such substances. The most aggressive were iodine, cadmium, and iron-contaminated cesium. Detailed studies were made of iodine-induced SCC of well-characterized samples of Zircaloy sheet and tubing. The results on pressurized, cladding-grade tubes indicated that a threshold stress must be exceeded for iodine SCC to occur. The threshold stress was sensitive to the microstructure of the Zircaloy and probably to in-reactor irradiation, but was not affected by the presence of an oxide film or by iodine concentration within the range studied. The existence of a threshold stress indicates that crack formation probably is the key step in iodine SCC. A detailed investigation of the crack formation process showed that the cracks responsible for SCC failure nucleated at locations in the metal surface that contained higher than average concentrations of alloying elements and impurities. A four-stage model of iodine SCC is proposed based on the experimental results and the relevance of the observations to PCI failures is discussed.

34982 (GKSS—77/E/21) **Development and investigation of a nodal method for the calculation of multi-dimensional neutron flux distributions in light-water reactors according to the J^{+-} concept.** Jager, W. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Physik; Kiel Univ. (Germany, F.R.). Fachbereich Mathematik-Naturwissenschaften). 1977. 138p. (In German). Dep. NTIS (US Sales Only), PC A07/MF A01.

Thesis.

The method is a nodal technique characterized by considering only mean values over larger subvolumes of the reactor core. The subvolumes are coupled with each other by collision probabilities. These collision probabilities are approximated by products of partial probabilities - escape and transition probabilities (J^{+-} concept). The J^{+-} approximation (BOXJ^{+-} code) was tested by comparison with a Monte Carlo code. It was shown that for not too small subvolumes with dimensions of more than about two free path lengths this approximation is admissible. By comparison with transport theoretical and fine-meshed diffusion calculations the accuracy of the nodal method in one-, two-, and three-dimensional geometry was tested. The results with respect to flux and power density distribution as well as multiplication factor agree well with the reference calcualtions. Larger deviations only occur in some cases in the reflector. The method, being well founded in neutron-physical respect and containing no empirical corrections, fulfils the requirements for reliability of the results demanded from fast multi-dimensional methods for core design.

34983 (NEDO—21424-1) **Amendment No. 1: 238 Nuclear Island containment bypass leakage sealing and testing methods.** Wester, E. (General Electric Co., San Jose, Calif. (USA). Nuclear Energy Engineering Div.). Jan 1978. 10p. Electric Co., San Jose, CA.

Revised and additional information on containment bypass leakage sealing and testing methods for the General Electric 238 Standard Reactor is presented.

34984 (NEDO—21480) **Boiling Water Reactor feedwater nozzle/sparger. Interim program report.** Fife, A.B.; Kobsa, I.R.; Riccardella, P.C.; Watanabe, H.T. (General Electric Co., San Jose, Calif. (USA). BWR Projects Dept.). Jul 1977. 348p. Electric Co., San Jose, CA.

Portions of document are illegible.

Several distinct problems have been experienced with the feedwater nozzle and sparger in BWR's. Sparger arm cracking, sparger flow hole cracking, sparger intergranular stress corrosion, and nozzle blend radius and bore cracking have been observed in various operating BWR's. Cracks in the nozzle are believed to be initiated by high cycle fatigue caused by cold feedwater and hot reactor water mixing and exposing the metal surface to rapid water temperature fluctuations. Once initiated the cracks may continue to grow as a result of reactor pressure and feedwater system temperature and flow fluctuations. An analytical treatment of this hypothesis is presented. A comprehensive test program to verify this hypothesis as well as to provide data for solutions to eliminate cracks are detailed. Solutions being considered are feedwater spargers with interference fit, spargers welded to the nozzle safe-end, cladding removal, and system changes to increase the minimum temperature of cold water through the spargers.

34985 (RISO—353) **Development of a model for the assessment of radiation fields around nuclear power plant components.** Lauridsen, K. (Research Establishment Risoe, Roskilde (Denmark)). Jan 1977. 106p. Dep. NTIS (US Sales Only), PC A06/MF A01.

A method is presented for the calculation of the radioactivity inventories of components in the coolant circuit of a nuclear power plant. The study concentrated on power plants with boiling water reactors of General Electric BWR/6 type. The model accounts for the transport of fission products and activation products between different components, as well as the exchange of material between the interior surfaces of a component and the bulk coolant in this component. A simple point-kernel shielding calculation is applied to evaluate the radiation field outside the components.

34986 (BNWL-tr—300) **Release of fission products at different power levels by a fuel rod having a welding defect.** Chenebault, P.; Durka, G.; Vivier, M.; Lasne, G. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Mar 1978. Translation of DMG report No. 123/76, Grenoble Nuclear Research Center. 43p. NTIS, MF A01.

Portions of document are illegible.

A LWR fuel rod (17 x 17 type) has been given a small hole simulating an initial welding defect. At the level of the upper end plug. The rod has been irradiated in a pressurized water loop in the reactor Siloe. The radioactive isotopes emitted in the coolant have been determined by quantitative gamma spectrometry: /sup 85m/Kr, ^{138}Xe, ^{133}I, ^{131}I. Conclusions from the results of these measurements are presented.

34987 **Hierarchy level scheme for quasi-optimum fuel assembly loading in boiling water reactors.** Sekimizu, K. (Nippon Atomic Industry Group Co., Ltd., Kawasaki, Japan). *Nucl. Technol.;* **37**: No. 3, 296-312(Mar 1978).

A quasi-optimum fuel assembly allocation scheme for boiling water reactors was proposed and confirmed. It is characteristic of the scheme that the criteria function is represented by fuel assembly allotment to fuel groups. For each fuel group, a required property is given beforehand, and fuel assemblies are allocated to the core to determine the group property as closely as possible. By using the scheme, a fuel assembly allocation is obtained that has a large cycle burnup within a restriction for the peak-to-average power ratio. Another allocation is obtained that results in a large burnup of discharged fuel using a different criteria function. However, it is impossible to obtain a strictly optimum solution for a given criteria function because of the vast number of possible fuel assembly allocations. The search range is reduced by adopting a two-step scheme. In the first step, an optimum allocation of fresh assemblies is searched for, based on proper criteria. Then, in the second step, without moving the fresh fuel assemblies, an allocation of reload fuel assemblies is determined that ascertains the required group property as closely as possible. Results of the numerical calculation show that the scheme is very useful for practical fuel assembly allocation.

34988 **Multivariable autoregressive model of the dynamics of a boiling water reactor.** Matsubara, K. (Japan Atomic Energy Research Inst., Ibaraki); Oguma, R.; Kitamura, M. *Nucl. Sci. Eng.;* **65**: No. 1, 1-16(Jan 1978).

An autoregressive (AR) model with pseudo-random binary sequence (PRBS) test signals was applied to the dynamics of the Japan Power Demonstration Reactor, a boiling water reactor (BWR). The decision of the order of the AR model was based on the Akaike criterion. Multi-input test signals of the PRBS were applied to the steam-flow control valve and the forced circulation pump speed control terminal. Seventeen variables including the instrumented fuel assemblies were observed. The AR model identification facilitated building the BWR dynamics model as a multivariable system. The experiment indicated that the BWR dynamics with

rather intensive nonwhite noise interference was effectively represented by the AR model, which was compared with a linear theoretical dynamics model. The results suggested that the identified AR model plays an important role in verifying, modifying, and improving the theeoretical dynamics model.

34989 Mechanical snubbers solve severe maintenance problem at nuclear plant. Glauser, J.E. (Pac Sci, Los Angeles, Calif). *Power Eng.;* **81**: No. 11, 108-109(Nov 1977).

Even before Nebraska Public Power District's 764-MW BWR at Cooper Nuclear Station went into commercial operation in the summer of 1974, severe hydraulic pipe snubber problems had been experienced throughout the plant during pre-operational testing. Monthly plant shutdowns required by the high failure rate of hydraulic pipe snubbers in the drywell were eliminated by installing replacement mechanical snubbers. These mechanical snubbers inherently avoid the problem areas experienced--seal failure and hydraulic fluid loss.

34990 Alteration of the reactor installation (reactor facility) at the Tsuruga Nuclear Power Station of the Japan Atomic Power Company. *Genshiryoku Iinkai Geppo;* **22**: No. 3, 9-10(Apr 1977). (In Japanese).

This is the report by the Atomic Energy Commission to the Prime Minister, and the report by the Committee on Examination of Reactor Safety to the Atomic Energy Commission of Japan concerning the subject matter is attached. The alteration is the employment of minimum critical power ratio of 1.23 for 7 x 7 type and 1.24 for 8 x 8 type fuel assemblies along with the adoption of a new evaluation method for reactor-core thermal characteristics (currently, minimum critical heat flux ratio of 1.9 or above). The safety of the altered reactor facility is well confirmed.

34991 Alteration of the reactor installation (reactor facility) at the Shimane Nuclear Power Station of the Chugoku Electric Power Co., Inc. *Genshiryoku Iinkai Geppo;* **22**: No. 3, 10-12(Apr 1977). (In Japanese).

This is the report by the Atomic Energy Commission to the Prime Minister, and the report by the Committee on Examination of Reactor safety to the Atomic Energy Commission of Japan concerning the subject matter is attached. The alteration is the employment of minimum critical power ratio of 1.26 for 7 x 7 type and 1.29 for 8 x 8 type fuel assemblies along with the adoption of a new evaluation method for reactor-core thermal characteristics (currently, minimum critical heat flux ratio of 1.9 or above). The safety of the altered reactor facility is well confirmed.

34992 Light-water-reactor version of the URANUS integral fuel-rod code. Lassmann, K.; Moreno, A. (Technische Hochschule Darmstadt (Germany, F.R.). Inst. fuer Reaktortechnologie). *Atomkernenergie;* **30**: No. 3, 207-215(1977).

The LWR version of the URANUS code, a digital computer programme for the thermal and mechanical analysis of fuel rods, is presented. Material properties are discussed and their effect on integral fuel rod behaviour elaborated via URANUS results for some carefully selected reference experiments. The numerical results do not represent post-irradiation analyses of in-pile experiments, they illustrate rather typical and diverse URANUS capabilities. The performance test shows that URANUS is reliable and efficient, thus the code is a most valuable tool in fuel rod analysis work. K. Lassmann developed the LWR version of the URANUS code, material properties were reviewed and supplied by A. Moreno.

34993 Dynamic behavior of nuclear power plant in a grid. Rao, M.H.P. (Madras Atomic Power Project, Kalpakkam (India)). pp 12-17 of Proceedings of the smposium on power plant dynamics and control. Bombay; Department of Atomic Energy (1976).

From Symposium on power plant dynamics and control; Bombay, India (23 Feb 1976).

See CONF-760265—.

Variations in demand for power supply from a power grid are reflected through a conventional turbine generator in the steam cycle of the nuclear power reactor incorporated in the grid. The steam cycle behaviour affects the reactor parameters which in turn reflect in the change of reactivity giving rise to many problems which are discussed with special reference to BWR and PHWR type reactors.

34994 Dynamic simulation of Tarapur Atomic Power Plant. Chamany, B.F.; Murthy, L.G.K.; Ray, R.N. (Bhabha Atomic Research Centre, Bombay (India)). pp 105-116 of Proceedings of the symposium on power plant dynamics and control. Bombay; Department of Atomic Energy (1976).

From Symposium on power plant dynamics and control; Bombay, India (23 Feb 1976).

See CONF-760265—.

A detailed dynamic model has been developed for the Tarapur BWR plant for digital simulation to study the transients originating from the reactor as well as the power grid. The model comprises of point kinetics neutronics, thermal hydraulics of core to simulate the boiling boundary shift, recirculating loops with the dynamics of the pumps and secondary steam generators and a simplified version of the turbine. All controls in detail, such as governing, pressure and level controls etc. have been included. The model has been validated by checking against actual plant transient behaviour recorded during the commissioning.

34995 Boiling water reactor transfer equations by noise analysis. Ram, K.S. (Indian Inst. of Tech., Kanpur. Dept. of Mechanical Engineering and Nuclear Centre); Emmerich, K.M. (Cincinnati Univ., Ohio (USA)). pp 225-236 of Proceedings of the symposium on power plant dynamics and control. Bombay; Department of Atomic Energy (1976).

From Symposium on power plant dynamics and control; Bombay, India (23 Feb 1976).

See CONF-760265—.

Noise analysis technique for acquiring nuclear reactor system parameters are receiving increased attention especially as applied to monitoring and diagnostic procedures. In order to assess the validity of the random noise technique, the essential elements of a typical boiling water reactor system were simulated on an analog computer and the frequency response of various system parameters was acquired by introducing sinusoidal and rancom noise variations in reactivity. The transfer functions obtained by noise analysis compare favourably with those obtained by using a sinusoidal driving function although the accuracy of the noise data is not as high. The advantage of the noise technique was found to be for measurements at higher frequencies where the use of sinusoidally varying reactivity is limited in reality by the power required to vary the position of a control rod.

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED

REFER ALSO TO CITATION(S) 34980, 34981, 34986, 35115, 35119, 35120, 35123, 35133, 35217, 35259, 35260, 35263, 35264, 35265, 35268, 35278, 35279, 35280, 35545, 35553, 35554, 36329

34996 (CEA-N—1973) **Low cycle fatigue of steels for nuclear pressure vessels in hot water.** Garnier, C.; Kowalczuk, G.; Roche, R.; Barrachin, B. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. des Etudes Mecaniques et Thermiques). Jul 1977. 40p. (In French). Dep. NTIS (US Sales Only), PC A03/MF A01.

The design curves in low cycle fatigue analysis are based on tests in air at room temperature. But the fatigue behavior may be affected by hot water environment when light water reactors are concerned. So it would be useful to get experimental results for reactor steel samples in such conditions. A general program on low cycle fatigue in hot water is in progress at Saclay in order to assess the conservatism of design fatigue curves. In order to keep control of water chemistry, the test rig is connected with the PRIMEAU loop and therefore a constant flow of water is get throught the specimens. Tested samples are small strips of rectangular cross section (2x10x61mm). They are loaded in circular bending with controlled deflection. Practically they are placed between four supports, two moving and two fixed. The water temperature is kept near 265°C while the oxygen and hydrogen contents and the pH are monitored. A frequency as low as 0.1cpm has been choosed in order to take into account time effects. Calibration tests in air at room temperature are also made with the same type of device. Tests are now in progress on austenitic alloys and the available results are given. Tests on a ferritic steel have been completed. The steel is the French steel for light water reactor vessels, its specification is roughly according with the specification ASTM 508 (Cl.3), but with special requirements. For these tests results, the best fit curve can be written: (epsilon.a)=5.6Nsup(-0.3), (epsilon.a)=strain amplitude, N=number of cycles at failure. There is no noticeable difference between hot water test results and air-room temperature results. Comparison is made with ASME criteria (for section III): the results are near the ASME best fit curve for ASTM 302 steel.

34997 Determination of the net free containment volume at the Trojan Nuclear Plant using an experimental-analytical technique. Fegan, G.R.; Herborn, D.I.; Lippincott, S.M. (Portland General Electric Co., OR). *Nucl. Technol.;* **37**: No. 1, 13-18(Jan 1978).

The net free volume of the containment is an essential parameter in the loss-of-coolant accident (LOCA) containment pressure analysis for pressurized water reactors. For an optimized emergency core cooling system performance due to the importance of backpressure during the reflood phase of a LOCA, it is necessary to have the predicted pressure quite close to the design pressure. Using a geometric analysis, an estimate of 56,241.99 m^3 (1,986,167 ft^3) for the net free volume has been made for the containment of the Trojan

nuclear plant. Two sets of data were produced from the normally scheduled structural integrity and integrated leak-rate tests on the Trojan containment. These data sets were used to arrive at two new estimates of the net free volume. A deterministic equation giving volume as a function of the slope of a linear relationship between depressurization and time was developed. After an analysis of the reliability of the data, estimates of this linear slope were made from the two data sets. These two slopes gave net free volume estimates of 58,000 m^3 (2.05 x 10^6 ft^3) and 57,650 m^3 (2.036 x 10^6 ft^3) when used in the deterministic equation. The maximum deviation from the geometric-based estimate was less than 4%.

34998 (PSAD—76-86) **Bellefonte Nuclear Plant, Tennessee Valley Authority.** Gutmann, R.W. (General Accounting Office, Washington, D.C. (USA)). 1 Mar 1976. 43p. Accounting Office, Washington, DC.

Study by the Staff of the U.S. General Accounting Office.

A detailed evaluation of the available cost and construction schedule data on the Bellefonte Nuclear Plant is presented.

34999 (XN-NF—77-57) **Exxon nuclear power distribution control for pressurized water reactors: Phase II.** Holm, J.S.; Burnside, R.J. (Exxon Nuclear Co., Inc., Richland, Wash. (USA)). 13 Jan 1978. 60p. Nuclear Co., Inc., Richland, WA.

The power distribution control procedure, denoted PDC-II, described in this report enables nuclear plants to manage core power distributions such that Technical Specification Limits on F/sub Q// sup T/ are not violated during normal operation and limits on MDNBR are not violated during steady-state, load-follow, and anticipated transients. The PDC-II data base described provides the means for predicting the maximum F/sub Q//sup T/(z) distribution anticipated during operation under the PDC-II procedure taking into account the incore measured equilibrium power distribution data for the reactor in question. A comparison of this distribution with the Technical Specification limit curve determines whether the Technical Specification limit can be protected by PDC-II procedure. If such protection can be confirmed for a given operating cycle interval, APDMS monitoring is not necessary over this interval and the excore monitored constant axial offset limits will protect the Technical Specification F/sub Q//sup T/ limits. This document describes the maximum possible variation in F/sub Q//sup T/(z) which can occur during operation when following the PDC-II procedures. This bounding variation in F/sub Q//sup T/(z) is referred to as V(z). This V(z) distribution represents the maximun variation in F/sub Q//sup T/(z) when the axial offset is maintained within the range defined in this report [+- 5% at full power condition].

35000 (ZfK—318) **SFAK - a programme for calculating the self-absorption of unscattered gamma radiation from fuel assemblies.** Wand, H. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (German Democratic Republic)). Nov 1976. 31p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Physical and mathematical fundamentals as well as the user's manual of the ALGOL programme SFKA written for the BESM-6 computer for calculating the self-absorption of unscattered gamma radiation within fuel assemblies are described. The capabilities of the programme are demonstrated for hexagonal assemblies of the WWER type.

35001 **Alteration of reactor installation (addition of unit 2) in the Ikata Power Station of Shikoku Electric Power Company, Inc.** *Genshiryoku Iinkai Geppo;* **22**: No. 3, 12-42(Apr 1977). (In Japanese).

This is the report by the Atomic Energy Commission to the Prime Minister, and the report by the Committee on Examination of Reactor Safety to the Atomic Energy Commission of Japan concerning the subject matter is attached. The alteration is the installation of a nuclear power plant, Unit 2, adjacent to the existing Unit 1 (under construction) in the Ikata Power Station; a PWR type with electric output of 566.5 MW. The safety of the altered reactor installation is well confirmed.

35002 **Modification of the reactor (Unit 1) in Genkai Nuclear Power Station of Kyushu Electric Power Co., Inc. (report).** *Genshiryoku Iinkai Geppo;* **21**: No. 11, 16(Feb 1977). (In Japanese).

A report of the Committee on Examination of Reactor Safety to the Atomic Energy Commission of Japan concerning the modification of a reactor is described. The modification is related to the usage of burnable poison distributed over the whole volume reactor core in the exchange, with a total of 584 poison rods (before the modification, such rods are used only in the initial core). The purpose is to retain intrinsic core safety and flat power distribution even when the core fuel is increased. The safety of the usage was confirmed.

35003 **Neutron monitoring instrumentation for BWR nuclear power plant.** Kai, T.; Tsubomoto, T.; Igari, K.; Takano, K. (Hitachi Ltd., Tokyo (Japan)). *Hitachi Hyoron;* **58**: No. 10, 819-824(Oct 1976). (In Japanese).

Neutron monitoring instrumentation is the important reactor instrumentation system indispensable to maintain the reactor safety. The in-core monitoring is adopted in all BWRs. Hitachi Ltd. realized the production of the neutron monitoring instrumentation highly reliable and able to meet the Japanese climate of high temperature and high humidity. The neutron source range monitoring system uses the highly sensitive fission counter, and fully satisfies the target specification of +-2% linearity and the resolution of 1 μs or less. Intermediate range monitoring system employs the Campbell method, and the n/γ ratio is improved by two figures as compared with DC method. Power range monitoring system is composed of the local power remote monitoring, average power remote monitoring, rod blocking monitoring and periodical instrument calibration systems. The parts used for this instrumentation system are strictly quality-controlled, and their operation rating was fully reduced because their number amounts to approximately 50000. Specifically, attention was paid to the endurance to humidity, and the electrical noise was reduced with metallic shield cases or conduit tubes. The reliability was tested and confirmed by assuming the loss of coolant accident. The resonance frequency was more than 36 Hz in aseismatic design. Acceleration test results were within the aimed accuracy, in which 3 g in x and y directions and 1 g in z direction were applied. The neutron monitoring instrumentation was designed by giving consideration to the maintainability because the number of measuring points are numerous due to the adoption of redundancy and the periodical calibration is required.

35004 **Heat exchanger.** Dostatni, A.W.; Dostatni, M. French Patent 2,309,818/E/. 8 Mar 1976. Priority date 10 Mar 1975, United States of America (USA). 8p. (In French).

In the main patent, a description was given of a heat exchanger with an exchange surface in preformed sheet metal designed for the high pressure and temperature service particularly encountered in nuclear pressurized water reactors and which is characterised by the fact that it is composed of at least one exchanger bundle sealed in a containment, the said bundle or bundles being composed of numerous juxtaposed individual compartments whose exchange faces are built of preformed sheet metal. The present addendun certificate concerns shapes of bundles and their positioning methods in the exchanger containment enabling its compactness to be increased.

POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED

REFER ALSO TO CITATION(S) 35044, 35096, 35129, 35130, 35131, 35134, 35592, 36329

35005 (GA-A—14802) **Component and Systems Development Program. Quarterly progress report for the period ending December 31, 1977.** (General Atomic Co., San Diego, Calif. (USA)). Jan 1978. Contract EY-76-C-03-0167-050. 190p. Dep. NTIS, PC A09/MF A01.

During the current quarter work under this program was continued in three major areas; (1) component and structural materials, (2) thermal barrier studies, and (3) reactor internals studies. The objectives of these tasks are to provide a data base for the properties of materials used in the construction of important noncore components of the HTGR and to demonstrate the adequacy of the thermal barrier and reactor internal design.

35006 (JAERI-M—7034) **Bibliographical survey of heat exchangers for nuclear power plants and problems of HTGR.** Yamao, H.; Okamoto, Y.; Sanokawa, K. (Japan Atomic Energy Research Inst., Tokyo). Apr 1977. 128p. (In Japanese, English). Dep. NTIS (US Sales Only), PC A07/MF A01.

The problems in development of heat exchangers for nuclear reactors have been examined in literature survey through Annual Index Subjects of NSA (Nuclear Science Abstracts) for the past ten years. R and D on heat exchangers for LMFBR, HTGR, LWR and HWR are on the increase. In the case of HTGRs, R and D on heat resisting materials including the corrosion and on hydrogen permeation of heat exchanger walls in high temperature pressure helium environment are important. Future R and D subjects for HTGR heat exchangers in showing the high temperature endurance are presented.

35007 (JAERI-M—7059) **DREAM-FLOW: a computer program for estimating the uncertainty of channel coolant flow rates of HTGR's core with the Monte Carlo method.** Satoh, S.; Miyamoto, Y. (Japan Atomic Energy Research Inst., Tokyo). Apr 1977. 57p. (In Japanese). Dep. NTIS (US Sales Only), PC A04/MF A01.

The computer program DREAM-FLOW is for estimating the uncertainty of flow rates in a multi-channel model such as HTGR's core of pin-in-block type fuel elements, taking notice of a fluctuation of the friction factor in the transitional flow. In the calculation procedure, the Monte Carlo method is used to generate random

numbers for the friction factor assumed to fluctuate in the transitional flow. Statistical properties of the flow rate and maximum fuel temperature caused by fluctuation of flow are predicted with the program. The calculational model and usage of the program are described. The program is written in FORTRAN-IV for computer FACOM230-75 and the required core memory is about 125 kilowords.

35008 (Juel—1394) **Suitability of Co as an alloy material for components of the primary circuit of HTR reactors.** Iniotakis, N. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorbauelemente). Feb 1977. 33p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

For high temperature reactors it is of interest if Co-alloys could be used for the different components of the primary cooling circuit. It has been investigated in detail to what amount the Co-60 created by neutron activation of Co-59 contained in the material of the components could possibly contribute to the contamination of the primary cooling circuit of the reactor. The result of these investigations is compared with the contamination of the cooling circuit by fission and activation products like Co-137, Cs-134, Ag-11om etc. For pebble bed reactors with an OTTO-type fuel management it could be shown that there is no limitation for the use of cobalt in alloys for materials of the components in the primary cooling circuit. The only boundary condition is that the local Thermal Flux at the position of the components should be less than phisub(th) $<= 10^{7}$ n/cm^{2}. sec.

35009 (Juel—1408) **Irradiation tests of THTR fuel elements in the DRAGON reactor (irradiation experiment DR-K3).** Burck, W.; Duwe, R.; Groos, E.; Mueller, H. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorwerkstoffe und Heisse Zellen). Mar 1977. 99p. (In German). Dep. NTIS (US Sales Only), PC A05/MF A01.

Within the scope of the program 'Development of Spherical Fuel Elements for HTR', similar fuel elements (f.e.) have been irradiated in the DRAGON reactor. The f.e. were fabricated by NUKEM and were to be tested under HTR conditions to scrutinize their employability in the THTR. The fuel was in the form of coated particles moulded into A3 matrix. The kernels of the particles were made of mixed oxide of uranium and thorium with an U 235 enrichment of 90%. One aim of the post irradiation examination was the investigation of irradiation induced changes of mechanical properties (dimensional stability and elastic behaviour) and of the corrosion behaviour which were compared with the properties determined with unirradiated f.e. The measurement of the fission gas release in annealing tests and ceramografic examinations exhibited no damage of the coated particles. The measured concentration distribution of fission metals led to conclusions about their release. All results showed, that neither the coated particles nor the integral fuel spheres experienced any significant changes that could impair their utilization in the THTR.

35010 (Juel—1421) **Recent working results of the programme 'diffusion data and fission product release'.** Amian, W.; Biedermann, P.; Hecker, R.; Herzing, R.; Max, A.; Overhoff, T.; Rueckert, M.; Stoever, D. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung). Jun 1977. 95p. (In German). Dep. NTIS (US Sales Only), PC A05/MF A01.

This report contains a compilation of single contributions, which were presented on the occasion of a series of lectures in the Institute of Reactor Development in March 1977. Results for Cs-diffusion in coated particles and spherical fuel elements are presented in detail and discussed in respect to their consequences. Besides this it is reported about progress in methodical development. By application of two independent methods the quantitative determination of the 'rare' silver isotope Ag-11om in high burnt-up HTR fuel succeeded. The new developed technique of laser drilling is presented in its basis. With the aid of results for Cs-release and distribution in coated particles the efficiency and the inserting potential of this method are proved. By this, first statements about the release behaviour of defect particles can be gained.

35011 (Juel—1430) **Preliminary measurements at a kohlestein insulation.** Broeckerhoff, P. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorbauelemente). Jun 1977. 109p. (In German). Dep. NTIS (US Sales Only), PC A06/MF A01.

A kohlestein insulation has been tested in the high pressure wind tunnel as an additional version of a thermal insulation. The material is labelled RUD-N. It was produced by the company Sigri in Meitingen/Germany. The insulation consisted of five rings, three of which were available for measurements. Air or helium, pressurized between 3 bars and 40 bars, were used as fluid. Maximum temperatures were 300°C for air and 200°C for helium. The maximum velocities of 20 m/s were reached. The gaps between the particular rings as well as between the pressure tube and the insulation caused increased heat fluxes due to axial pressure gradients. Thus unsymmetrical temperature and heat flux distributions were observed.

35012 (Juel—1441) **Thermodynamical calculations and design for a vessel-cooling of a HTR constructed of prestressed cast-steel segments with a thermal power of 3,000 MW(th).** Scheler, J. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung; Technische Hochschule Aachen (Germany, F.R.)). Jul 1977. 109p. (In German). Dep. NTIS (US Sales Only), PC A06/MF A01.

Thesis.

The fulfilling of the safety requirements for a vessel-cooling-system of a HTR cast-steel vessel leads to the application of an even-even-plate-type of cooling-system, which is block-independent and therewith, in principle, exchangeable. From the consideration of thermal accidents, the results obtained show that due to the fall-out of a cooling-disk, no damages are to be expected to the vessel, because of increased temperatures. For larger break-downs, the time interval is sufficient for countermeasures to be taken. The dimensions of the cooling system of the control rods are such that for a fall-out of the top-cooling, too, a safe reactor operation, and therefore also the starting-up of the reactor, remains possible at any time.

35013 (KFA-IRW-IB—21/75) **Method for predicting the behaviour of materials in high temperature reactor (HTR) environments using a computerised thermodynamic approach.** Glaze, F.J.; Pfeifer, J.P. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorwerkstoffe und Heisse Zellen). Oct 1975. 14p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The purpose of this report is to consider the thermodynamic aspects of the behaviour of materials in typical high temperature reactor environments. An earlier report described the use of thermodynamics in predicting the behaviour of materials in impure helium of the type likely to be encountered in HTRs and this report is an extension of the earlier one. A computer programme has been written to facilitate the preduction of materials' behaviour and a detailed description of this programme is given here. The use of the programme is illustrated by evaluating the likely behaviour of a given alloy (INCOLOY alloy 807) in a specific helium environment (ZEMAK-I).

35014 **Method to produce fuel element blocks for HTR reactors.** Hrovat, M.; Rachor, L. (to Hochtemperatur-Reaktor-Brennelement G.m.b.H. (HOBEG), Hanau (Germany, F.R.)). German(FRG) Patent 2,609,476/B/. 12 May 1977. 2p. (In German).

The patent claim relates to one partial step of the multi-stage pressing process in the production of fuel elements. A binder resin with a softening point at least 15°C but preferably 25-40°C above the melting point of the lubricant is proposed. The pressed block is expelled from the forging die in the temperature interval between the melting point of the lubricant and the softening point of the binder resin. The purpose of the invention is that the pressed fuel element blocks are expelled from the machine tool without damage at a pressure low enough to protect the mechanical integrity of the coated fuel particles or fertile particles.

35015 **Dynamic behaviour of experimental multi-purpose high temperature reactor.** Takaya, J. (Fuji Electric Co. Ltd., Kawasaki, Kanagawa (Japan)). *FAPIG (Tokyo);* No. 83, 8-12, 48(Nov 1976). (In Japanese).

The multi-purpose high temperature reactor is being developed by JAERI and others for the purpose of supplying nuclear thermal energy at high temperature, and the thermal output of the experimental reactor is 50 MW, and the outlet coolant temperature is 1000 deg C. This experimental reactor is the graphite-moderated, helium-cooled reactor, therefore it has good characteristics for the safety, such as negative reactivity temperature factor, the large heat capacity of the core, coolant without phase transformation and so on. The plant construction is indirect cooling type, and the heat from the reactor is transmitted to heat-utilizing systems through an intermediate heat exchanger, consequently the transient characteristics of the plant differ from those of conventional gas-cooled reactors. The operational characteristics when the output is raised from 30% to 100%, the control characteristics at the time of the rated output operation, and the analysis of the plant behavior at the time of emergency are explained. By limiting the range of changing the flow rate of primary coolant, the rate of output rise is limited to 0.2%/min, and the convergence of outlet temperature at the time of imposing reactivity disturbance is somewhat delayed. The pressure difference between the primary and secondary systems must be maintained even at the time of plant emergency, and special consideration is required for the operation after abnormality arose.

35016 **Resistance of zirconium alloys to fracture.** Rivkin, E.Yu.; Vasnin, A.M.; Mozharov, V.E. *Sov. Mater. Sci. (Engl. Transl.);* **12**: No. 6, 589-593(1976).

On the basis of experimental data, it is shown that the fracture resistance of zirconium alloys is essentially dependent upon the degree of hydrogen saturation and irradiation. In their initial state, zirconium alloys are tough and plastic. On exposure to hydrogen saturation and irradiation they become brittle, and their critical brittleness temperature shifts into the positive temperature region.

Brittle fracture of zirconium alloys therefore proves to be possible in principle. The analysis using crack opening Δ/sub c/ as the criterion of fracture has made it possible to establish the relationships between the critical dimensions of defects in zirconium alloy tubes and the breaking stresses, to define the conditions under which a surface defect existing in a tube may lead to complete fracture by developing into a through crack, and to assess the extent of the danger of tube fracture in the RBM-K reactor pipework in the first unit at the Leningrad Atomic Power Station. 10 refs.

POWER REACTORS, NON-BREEDING, OTHERWISE MODERATED OR UNMODERATED

REFER ALSO TO CITATION(S) 35209, 35210, 35296, 35545

35017 (AECL—5700) **Potential of remote multiplexing systems in reducing cabling cost and complexity in nuclear power stations.** Stirling, A.J.; L'Archeveque, J.V.R. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Mar 1977. 54p. Dep. NTIS (US Sales Only), PC A04/MF A01.

Control and instrumentation cabling accounts for nearly 1% of the capital cost of a CANDU generating station. This study of cabling requirements, methods and costs for nuclear reactors, shows that efficient design and scale economies make CANDU wiring costs (per field point) among the lowest for comparable applications. Although attractive in other reactors, commercially available remote multiplexing systems are not, as yet, cost effective for general use in CANDU stations. The report, with its comprehensive tabulation of remote multiplexing equipment, and analysis of cabling procedures describes an approach for re-evaluating the tradeoff between remote multiplexing and conventional wiring as conditions change.

35018 (AEEW-R—1098) **Absorption of thermal radiation by water films.** Pearson, K.G.; Elliott, D. (UKAEA Reactor Group, Winfrith. Atomic Energy Establishment). Apr 1977. 22p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Except at the shortest wavelengths (i.e. $<2\mu m$) liquid water is relatively opaque to thermal radiation. It is also a poor reflector, reflecting back only about 2% of normal incident radiation. It is shown that when radiation falls on a plane water surface from a parallel heated surface about 93.5% of the incident radiation enters the surface, the remaining 6.5% being reflected back to the source. It is also shown that, for source temperatures up to the maximum of interest in reactor safety studies, a large fraction of the thermal radiation which enters the water is absorbed on passing through a distance approaching 0.5 mm. Since liquid water films of such thickness can be expected to exist on the pressure tubes of an SGHWR following a loss of coolant accident it follows that, irrespective of the condition of the pressure tube wall, the absorptivity of the pressure tubes will in effect be about 0.9. Data are presented for experiments performed to determine the absorptivity of water films on a polished surface whose dry absorptivity was measured to be 0.18. The presence of the water film, of estimated thickness 0.3 mm, increased the absorptivity of the surface to a value close to unity.

35019 **Flow transients in hydraulic loops (incompressible flow).** Chamany, B.F.; Murty, L.G.K.; Ray, R.N. (Bhabha Atomic Research Centre, Bombay (India)). pp 220-224 of Proceedings of the symposium on power plant dynamics and control. Bombay; Department of Atomic Energy (1976).

From Symposium on power plant dynamics and control; Bombay, India (23 Feb 1976).

See CONF-760265—.

A general purpose hydraulic flow transient program has been developed for incompressible flow. Any number of nodes interconnected through lines with pumps and control valves in the lines can be represented. The transients in each part of the loop can be followed for any disturbance occuring in the system. The momentum equations are solved either numerically or by an iterative analytical technique. The RAPS primary heat transport system has been analysed for various transients.

35020 (ZJE—164) **Analysis of shutdown and aftercooling cycles of the A-1 nuclear power plant.** Mueller, V.; Vopatril, M. (Skoda, Plzen (Czechoslovakia). Zavod Vystavba Jadernych Elektraren). 1977. 47p. Dep. NTIS (US Sales Only), PC A03/MF A01.

A new concept is described of the emergency shutdown and after-cooling of the A-1 reactor based on the elimination of pressure shock and minimization of thermal shock. After-cooling is effected by all circulators which had not been defective before shutdown. During shutdown the pumps run at reduced speed. A diesel generator is used as a self-contained power supply. The after-cooling is classified into three types depending on the machinery power consumption, i.e., normal, emergency and super-emergency. The selection of the power supply and the after-cooling conditions proceeds automatically. A mathematical model is described of A-1 reactor behaviour during different accidents requiring the shutdown and after-cooling.

35021 (ZJE—190) **Surveillance programs prepared and carried out during production and exploitation of the A-1 nuclear reactor pressure vessel.** Brumovsky, M.; Filip, R.; Cervasek, J.; Vacek, M. (Skoda, Plzen (Czechoslovakia). Zavod Vystavba Jadernych Elektraren). 1976. 32p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The A-1 reactor pressure vessel characteristics are given. The philosophy of the surveillance specimens programme and surveillance test programme of the A-1 reactor pressure vessel are described. The first two stages of the evaluation of the surveillance specimens programme of the A-1 reactor pressure vessel were completed. Valuable data on pressure vessel material behaviour (basic material and welded joints) during neutron irradiation were attained.

35022 (ZJE—192) **Non-destructive tests and measurements performed on a nuclear reactor under operation.** Prepechal, J. (Skoda, Plzen (Czechoslovakia). Zavod Vystavba Jadernych Elektraren). 1976. 12p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Experience is summed up gained in the development of the in-reactor inspection method on the A-1 nuclear power plant reactor in Czechoslovakia. The first testing equipment specially developed in Czechoslovakia for this purpose and used for the in-service inspection of the nuclear reactor was the equipment for measuring calandria wall thickness by ultrasonic waves. Some in-reactor components were inspected visually using a special optical equipment (introscope) having an overall length of 23 m. The ultrasonic examination of one circumferential weld of the A-1 reactor pressure vessel was carried out by a currently used manual method. Experience gained with safety and occupational hygiene in in-service inspections of the A-1 nuclear power plant is described.

35023 **Substitution measurements on 28-fuel-rod critical clusters in D_2O and their analysis by the second-order perturbation method.** Shiba, K. (Power Reactor and Nuclear Fuel Development Corp., Ibaraki, Japan). *Nucl. Sci. Eng.;* **65**: No. 3, 492-507(Mar 1978).

Material bucklings have been determined as functions of ^{235}U enrichment in UO_2 (0.7, 1.2, and 1.5 wt % ^{235}U), PuO_2 enrichment in PuO_2-UO_2 (0.54 and 0.87 wt % PuO_2), fissile content of plutonium (91 and 75% Pu-fissile), lattice pitch (V/sub mod//V/sub fuel/: 7.4 and 9.9), and coolant void fraction. The reference loading of 1.2 wt % ^{235}U-enriched UO_2 clusters was progressively replaced by the test clusters. Buckling differences resulting from the substitutions were analyzed by the new second-order (iterative) perturbation method, on the assumption that neutron diffusion is isotropic and that no difference in diffusion coefficients exists between the two lattices. This analysis takes into account the effect of distortion in radial neutron flux distribution in the substituted core without any iterative correction procedure that is usually adopted in the first-order perturbation method. Also, it is not necessary in the case of the present analysis to introduce any usual intermediate region for taking into account the effect of spectrum mismatch between two lattices. The material buckling differences between the test and reference lattices, which are in the range of -10.2 to 9.1 m^{-2}, were determined within 3% of uncertainty.

35024 **Resource utilization of symbiotic high-temperature gas-cooled reactor systems.** Borgonovi, G.M.; Brogli, R.H. (General Atomic Co., San Diego, CA). *Nucl. Technol.;* **37**: No. 3, 196-203(Mar 1978).

The cumulative uranium requirements of different symbiotic combinations of high-temperature gas-cooled reactor (HTGR) prebreeders have been calculated assuming an open-end nuclear economy. The results obtained indicate that the combination of prebreeders and near-breeders does not save resources over a self-generated recycle case of comparable conversion ratio, and that it may take between 40 and 50 yr before the symbiotic system containing breeders starts saving resources over an HTGR with self-generated recycle and a conversion ratio of 0.83.

35025 **Progress at Gentilly-2.** Boucher, R. pp 2-10 of Canadian Nuclear Association--annual international conference proceedings, 17, Volumes 1 through 6, 1977. Montreal; Canadian Nuclear Association (5 Jun 1977).

From 17. annual international conference of the Canadian Nuclear Association; Montreal, Ontario, Canada (5 Jun 1977).

This report describes the construction progress at Hydro-Quebec's Gentilly-2 station, as of mid-April 1977. The construction program shows November 1979 as the forecast commercial operation date. Since its start, progress at Gentilly-2 has been affected by long delivery delays on major components. The work status of the reactor building, turbine building, service building, water system, sub-station and administration building is discussed.

35026 **Gentilly-2 rings in Quebec's nuclear era.** *Mod. Power Eng.;* **71**: No. 6, 42(Jun 1977).

Scheduling, cost, and suppliers of equipment for Gentilly-2 nuclear power station are briefly discussed. An increase of cost has been due to an extension of the construction period, to additional requirements of the AECB, and to other causes. Some other possible nuclear sites in the province are mentioned.

35027 Modified Gentilly-1 will provide clean process steam for La Prade. *Mod. Power Eng.;* **71**: No. 6, 43(Jun 1977).

The Gentilly-1 CANDU-BLW power plant is being modified by putting in reboilers so that clean steam (free of radioactivity) can be supplied to the La Prade heavy water plant. The sensitivity of the reactor core to variations in coolant pressure imposes restraints on variation of pressure in the steam drum.

35028 Progress at point Lapreau. Gunter, G.E. pp 11-22 of Canadian Nuclear Association--annual international conference proceedings, 17, Volumes 1 through 6, 1977. Montreal; Canadian Nuclear Association (1977).

From 17. annual conference proceedings of the Canadian Nuclear Association; Montreal, Ontario, Canada (5 Jun 1977).

This paper is a report on the status of engineering, manufacturing and construction for the Point Lepreau Generating Station to the end of April, 1977. In addition a very brief description of the station is presented and some of the more interesting features are highlighted.

35029 Cordoba and Wolsung projects--a progress report. Brooks, G.L.; Foulkes, F.M. pp 23-41 of Canadian Nuclear Association--annual international conference proceedings, 17, Volumes 1 through 6, 1977. Montreal; Canadian Nuclear Association (1977).

From 17. annual international conference of the Canadian Nuclear Association; Montreal, Ontario, Canada (5 Jun 1977).

This paper describes the standardized 600 MWe CANDU-PHW design and its application in two power plants. Progress reports for the Cordoba plant in Argentina and the Wolsung plant in Korea are given and difficulties in the contract negotiations, economic climates, and construction conditions are described. 1 ref.

35030 Use of high density concrete. Elliott, R.A.; Trihey, H.O. (Nucl Shielding Supplies and Serv of Can, Ltd). pp 17-18 of Canadian Nuclear Association--annual international conference proceedings, 17, Volumes 1 through 6, 1977. Montreal; Canadian Nuclear Association (1977).

From 17. annual international conference of the Canadian Nuclear Association; Montreal, Ontario, Canada (5 Jun 1977).

This extended abstract briefly describes the advantages of iron-aggregate concrete and ilmenite high density concrete in reactor shielding.

35031 Thermofluids research and development program at chalk river nuclear laboratories. Ahmad, S.Y. (AECL). pp 28-30 of Canadian Nuclear Association--annual international conference proceedings, 17, Volumes 1 through 6, 1977. Montreal; Canadian Nuclear Association (1977).

From 17. annual international conference of the Canadian Nuclear Association; Montreal, Ontario, Canada (5 Jun 1977).

This extended abstract describes the current heat transfer and fluid dynamics studies at Chalk River Nuclear Laboratories, including investigations of nucleate boiling and experiments in a steam-water loop and freon loop.

35032 Xenon override capability in Pickering A reactors. Akhtar, P.; Trojan, O.A. (AECL). pp 83-85 of Canadian Nuclear Association--annual international conference proceedings, 17, Volumes 1 through 6, 1977. Montreal; Canadian Nuclear Association (1977).

From 17. annual international conference of the Canadian Nuclear Association; Montreal, Ontario, Canada (5 Jun 1977).

This extended abstract discusses the Pickering A reactors' adjuster rod operation and their effect on reactor power behavior. Reactor operation during xenon override tests is compared with normal reactor operation.

35033 Advances in CANDU fuel: past and future. Bain, A.S.; MacEwan, J.R.; Hardy, D.G. (AECL). pp 121-123 of Canadian Nuclear Association--annual international conference proceedings, 17, Volumes 1 through 6, 1977. Montreal; Canadian Nuclear Association (1977).

From 17. annual international conference of the Canadian Nuclear Association; Montreal, Ontario, Canada (5 Jun 1977).

This extended abstract describes advances in Candu fuel design while retaining the basic concept of a 500 mm long assembly of elements containing UO_2 pellets, sheathed with Zircaloy tubes that are collapsible under the coolant pressure and are supported by the pellets. Advances include the method of element spacing, dropping of autoclaving, and the inclusion of a lubricating layer between the fuel and the sheath.

35034 Modelling of fuel element behavior. MacEwan, J.R.; Notley, M.J.F.; Tamm, H. (AECL). pp 124-126 of Canadian Nuclear Association--annual international conference proceedings, 17, Volumes 1 through 6, 1977. Montreal; Canadian Nuclear Association (1977).

From 17. annual international conference of the Canadian Nuclear Association; Montreal, Ontario, Canada (5 Jun 1977).

This extended abstract describes the computer codes ELESIM and FULMOD and discusses their application to nuclear fuel performance analysis during normal reactor operation. 2 refs.

35035 Transient characteristics of RAPS turbo-alternators. Chakraborty, G. (Bhabha Atomic Research Centre, Bombay (India)); Saha, T.N. (Indian Inst. of Tech., Kanpur). pp 319-342 of Proceedings of the symposium on power plant dynamics and control [held at Bombay during] February 23-24, 1976. Bombay; Department of Atomic Energy (1976).

From Symposium on power plant dynamics and control; Bombay, India (23 Feb 1976).

See CONF-760265—.

In India the nuclear power generating units are quite large, compared to the existing thermal and hydro units. Moreover, the mechanism of energy conversion and the mode of control of various stages involved therein are markedly different in nuclear power stations for those used in conventional thermal or hydro stations. It is, therefore, expected that the performance characteristics of nuclear plants, praticularly during load transients, will also be different and matching the operation of these units with the rest of the system may require extensive analysis of the system and determination of the areas where design modification may be necessary. The operational characteristics of RAPS turbo-alternator set with automatic voltage regulator (AVR) and speed governor are investigated, when this unit is subjected to large disturbances such as complete load rejection, failure of governor, long duration faults etc. Electrodynamic model of the generator along with AVR and speed governor have been simulated in digital computer for calculating the responses.

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REFER ALSO TO CITATION(S) 34615, 35240, 35241, 35242, 35251, 35253, 35258, 35272, 35273, 35276, 35277, 35281, 35298, 35544, 35549, 35550, 35551, 35563, 35572, 35574, 35575, 35576, 35577, 35578, 35579, 35580, 35581, 35582, 35583, 35584, 35585, 35586, 35587, 35588, 35589, 35590, 35591, 35595, 35596, 35597, 35598, 35599, 35600, 35603, 35604, 35605, 35606, 35607, 35608, 35610, 35611, 35612, 35613, 35614, 35616, 35641, 35642, 35643

35036 (AI-DOE—13220) **Quarterly technical progress report. Sodium technology and cover gas seal development programs. October—December 1977.** (Rockwell International Corp., Canoga Park, Calif. (USA). Rocketdyne Div.). 15 Feb 1978. Contract EY-76-C-03-0824-027. 21p. .

Progress is summarized in FFTF-LMFBR cover gas seals testing and design and in sodium removal and decontamination techniques. (DG)

35037 (AI-DOE—13221) **Quarterly technical progress report cover gas seal components and sodium component development programs. October—December 1977.** (Rockwell International Corp., Canoga Park, Calif. (USA). Rocketdyne Div.). 30 Jan 1978. Contract EY-76-C-03-0824-026. 20p. .

Progress is summarized in LMFBR cover gas seals development and testing and in studies of sodium wetting of fuel handling subcomponents. (DG)

35038 (AI-DOE—13222) **High-temperature piping design technology. Quarterly technical progress report, October—December 1977.** (Rockwell International Corp., Canoga Park, Calif. (USA). Rocketdyne Div.). 15 Feb 1978. Contract EY-76-C-03-0824-026. 11p. .

Progress is summarized in the following LMFBR piping design studies: collection of sodium piping failure data, analysis of piping systems with prior successful operating history, evaluation of sensitvity of piping design margins to variability in materials and geometry, and high cycle fatigue behavior at elevated temperature. (DG)

35039 (AI-DOE—13226) **Performance tests of sodium dip seals.** Shimazaki, T.T. (Atomics International Div., Canoga Park, Calif. (USA)). 28 Feb 1978. Contract EY-76-C-03-0824. 110p. .

Tests made on the CRBR sodium dip seal show that it meets all its capability requirements, provided the 400°F dip seal walls are wetted. It was demonstrated that the dip seal walls can be wetted at 400°F by either initially tin-plating the surface at room temperature by the brush electroplating process or by subjecting the submerged 400°F surface to ultrasonic energy. Data were also obtained on argon convection and sodium frost deposition in the upper annulus, corrosion of SA508 Class II steel in sodium, mass transfer coefficient

for O_2 in sodium, and effect of solids buildup in dip seal on plug rotational binding.

35040 (ANL-CT—78-14) **Neutron induced current pulses in fission chambers.** Taboas, A.L.; Buck, W.L. (Argonne National Lab., Ill. (USA)). Jan 1978. Contract W-31-109-ENG-38. 28p. Dep. NTIS, PC A03/MF A01.

The mechanism of neutron induced current pulse generation in fission chambers is discussed. By application of the calculated detector transfer function to proposed detector current pulse shapes, and by comparison with actually observed detector output voltage pulses, a credible, semi-empirical, trapezoidal pulse shape of chamber current is obtained.

35041 (CEGB-RD/B/N—3810) **Local blockage studies in a heated multipin water experiment with fast reactor geometry.** Clare, A.J. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). May 1977. 40p. Dep. NTIS (US Sales Only), PC A03/MF A01.

An important stage in studying the effects of local blockages in LMFBR subassemblies concerns the prediction of the elevated coolant temperatures in the downstream recirculating wake, and in particular the size of blockage which would cause boiling of the coolant. The development of both sophisticated models of the flow and heat transfer in the wake (such as the UK code SABRE), and simpler empirical methods, requires adequate experimental support including measurements of wake temperature patterns in large cluster experiments. Results are reported of a detailed study of wake temperature distributions produced in single-phase flow by blockages in a 283 pin (91 heated) water experiment. Two central blockages (7.2% and 12.8% of total flow area blocked) and two corner blockages (5.4% and 8.7% blocked) have been studied.

35042 (CEGB-RD/B/N—4040) **Preliminary assessment of the significance of defects in an idealised CFR diagrid design.** Darlaston, B.J.L.; Griffiths, J.E. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). Jun 1977. 18p. Dep. NTIS (US Sales Only), PC A02/MF A01.

A preliminary analysis is presented of an idealised CFR diagrid which is not the most recent design but is one for which a reasonably full stress analysis is available. A suitable and acceptable method is indicated for assessment of defects in the structure. When more precise information on loading and materials becomes available it will be necessary to repeat the calculations in a more rigorous manner. Limit load and linear elastic fracture mechanics analyses have been carried out for the top plate, bottom shell, and knuckle of the diagrid, underlying considerations of the effect of residual stresses. The top plate has been considered in detail using the CEGB failure assessment route.

35043 (CONF-771123—2) **Potential of large heterogeneous reactors.** Barthold, W.P.; Tzanos, C.P.; Beitel, J.C. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 24p. Dep. NTIS, PC A02/MF A01.

From BNES conference on optimization of sodium cooled fast reactors; London, UK (28 Nov 1977).

Different 1200 MWe heterogeneous core configurations have been evaluated and compared with a homogeneous 1200 MWe LMFBR design. This study discusses the neutronic coupling concept which was employed to discriminate between different heterogeneous core designs. Reactivity control, breeding performance, safety parameters, fuel pin optimization, transient behavior and thermal performance were investigated in detail and results of these analyses are presented.

35044 (CONF-780215—2) **Needs for development in nondestructive testing for advanced reactor systems.** McClung, R.W. (Oak Ridge National Lab., Tenn. (USA)). 1978. Contract W-7405-ENG-26. 23p. Dep. NTIS, PC A02/MF A01.

From Conference on NDE in the nuclear industry; Salt Lake City, UT, USA (13 Feb 1978).

The needs for development of nondestructive testing (NDT) techniques and equipment were surveyed and analyzed relative to problem areas for the Liquid-Metal Fast Breeder Reactor, the Molten-Salt Breeder Reactor, and the Advanced Gas-Cooled Reactor. The paper first discusses the developmental needs that are broad-based requirements in nondestrutive testing, and the respective methods applicable, in general, to all components and reactor systems. Next, the requirements of generic materials and components that are common to all advanced reactor systems are examined. Generally, nondestructive techniques should be improved to provide better reliability and quantitativeness, improved flaw characterization, and more efficient data processing. Specific recommendations relative to such methods as ultrasonics, eddy currents, acoustic emission, radiography, etc., are made. NDT needs common to all reactors include those related to materials properties and degradation, welds, fuels, piping, steam generators, etc. The scope of applicability ranges from initial design and material development stages through process control and manufacturing inspection to in-service examination.

35045 (GA-A—14723) **Preliminary seismic analysis of the GCFR core and core support structure.** Johnson, J.J.; Almajan, I.T.; Lee, T.H.; Wesley, D.A. (General Atomic Co., San Diego, Calif. (USA)). Dec 1977. Contract EY-76-C-03-0167-023. 195p. Dep. NTIS, PC A09/MF A01.

The preliminary dynamic analysis of the GCFR core support structure including the effects of the core elements is reported. The basic approach assumes the core support structure, i.e., the grid plate and its support cylinder, and the core elements to be represented as axisymmetric linear structures. The response of such axisymmetric bodies when subjected to asymmetric loadings may be determined by representing the circumferential variation of the load and the response as a Fourier series, solving for each harmonic separately, and using linear superposition to combine the results. This is an accurate representation of the grid plate and its support cylinder, but is only approxmately valid for the core elements. Time history response is provided for three assumed site conditions.

35046 (GEFR—00156) **Core restraint system seismic modeling capabilities.** Fakhari, M.; Fox, J.N. (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). Nov 1977. Contract EY-76-C-03-0893-023. 249p. .

Due to the lack of adequate analytical tools and supporting test data, seismic response is the most difficult design area of core restraint. The primary concerns of seismic response are: the reactivity changes associated with both horizontal and vertical motions of the core assemblies; the structural integrity of the core assembly load pads and duct walls under the influence of seismic loading; and the horizontal displacements of the upper ends of the core assemblies which could potentially interfere with control rod insertion. The information herein addresses both analytical modeling and testing; however, this information is preliminary since it represents less than 20% of the over-all effort required to adequately evaluate core restraint system seismic response.

35047 (GEFR—00258) **Reference fuel studies semi-annual report, February—July 1977.** (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). Oct 1977. Contract EY-76-C-03-0893-003. 128p. .

Research progress is reported for the following LMFBR-related subtasks: (1) fuel pin chemistry and thermodynamics, and (2) fuel pin testing and analysis.

35048 (GEFR—00291) **Vented assembly core development program, FY-77.** Dubberley, A.E. (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). Sep 1977. Contract EY-76-C-03-0893-020. 186p. .

Information on LMFBR vented assembly cores is presented concerning thermal-hydraulic performance, vent flow uncertainties, load pad mechanical performance, and core economic performance.

35049 (GEFR—13771-24) **Critical experiments and analysis twenty-fourth quarterly report, July—September 1977.** (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). Oct 1977. Contract EY-76-C-03-0893-005. 132p. .

Current activities and technical progress for the period July through September 1977 are reported for two subtasks. Subtask A covers the technical direction for critical experiments and analysis as applicable to LMFBR commercial plants and the Clinch River Breeder Reactor Plant Benchmark Critical Experiments in ZPPR Assembly 4 and the CRBRP EMC. Subtask B is directed towards the analysis of advanced fuels critical experiments that can provide a consistent data base for testing the computational tools, nuclear analysis techniques and basic nuclear data which are used in the LMFBR design effort, and for evaluating the nuclear performance and safety characteristics of advanced fuel materials.

35050 (GEFR-SP—042) **Design, manufacturing, and test status of the CRBRP hockey stick steam generators.** Little, A.F.; Bashford, A.L. (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). Nov 1977. Contract EY-76-C-03-1142;EY-76-C-03-1143. 41p. (CONF-780203—3). Dep. NTIS, PC A03/MF A01.

From 1. joint U.S./Japan LMFBR steam generator seminar; Tokyo, Japan (13 Feb 1978).

Portions of document are illegible.

The history of the development of the hockey stick steam generator, currently being designed and fabricated for use in the CRBRP, is traced back to its inception in the late 1960's. Additional supporting development, which has formed the basis for the current CRBR design, is presented. The design requirements for the CRBR steam generators are outlined and the basic design, which has been evolved to meet those requirements, is described. Of particular interest to the designer are the design analysis problem areas which have been encountered and the method of attack which has been employed to resolve these problems. In particular, the method of handling the creep characteristics of $2\frac{1}{4}$ Cr—1 Mo, as developed by

the material properties program at ORNL, is presented. Finally, the current status of the prototype and CRBRP steam generator plant unit production effort is described. The critical tube-tubesheet welding and automated MIG welding of shell sections--developed especially for the CRBRP steam generators--is discussed.

35051 (GEFR-SP—045) **Corrosion and impurities deposition effects under DNB conditions.** Rush, D.J.; Hampton, L.V.; Spalaris, C.N.; Schmidt, D.K.; Padden, T.R. (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). Nov 1977. Contract EY-76-C-03-0962. 21p. (CONF-780203—4). Dep. NTIS, PC A02/MF A01.

From 1. joint U.S./Japan LMFBR steam generator seminar; Tokyo, Japan (13 Feb 1978).

A summary of two separate steam generator model test programs, including a description of the test models, test systems, control and monitoring of water chemistry, in situ nondestructive examination methods and results, post-test destructive examination methods and results, are presented. The test programs described are: the DNB Corrosion Effects test program conducted by General Electric which comprised a sodium-heated single-wall-tube test model with a 4.9 m (16 feet) active heat transfer length and a single-wall heat transfer tube with 10.1 mm inside diameter prototypic of the CRBR steam generator tubing; and the Small Steam Generator Model corrosion test program conducted by Westinghouse which comprised a sodium-heated double-wall tube with 14.5 mm inside diameter and 18.6 m (60.9 feet) sodium heated length. The objectives of these tests were to determine whether accelerated or localized damage would occur as a result of DNB operation. The two parameters varied were caustic level and heat transfer. The GE, or "prototypic," test was conducted at an extreme condition of the plant specifications: 9 +- 3 ppB Na and thermal conditions corresponding to 64% plant power where the heat flux and tube wall temperature oscillations are maximum at 1.26×10^6 W/m^2 (0.4×10^6 Btu/hr-ft^2) and 56.7°C (102°F), respectively. The Westinghouse test was conducted at a 30 ppB sodium ion content to simulate worst-case conditions under which the CRBR might be operated with the thermal conditions corresponding to the less severe 100% power condition where the heat flux is about 0.75×10^6 W/m^2 (0.24×10^6 Btu/hr-ft^2).

35052 (GEFR-SP—046) **Fabrication inspection of tubing, tubesheets, and tube-to-tubesheet welds for the CRBRP steam generators.** Spalaris, C.N.; Durand, R.E.; McClung, R.W.; Wright, E.A. (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). Nov 1977. Contract EY-76-C-03-0893. 33p. (CONF-780203—5). Dep. NTIS, PC A03/MF A01.

From 1. joint U.S./Japan LMFBR steam generator seminar; Tokyo, Japan (13 Feb 1978).

The rationale for the technical details leading to the selection of tubing and tubesheet specifications and inspection techniques was based upon the desire to optimize the chances of success for the CRBRP steam generators. Fabrication processes, especially welding for the tube-to-tubesheet joints were recognized as critical. Thus, heavy emphasis was placed upon the development of reliable welding techniques as well as inspection methods using the most accurate and sensitive tools available. Accomplishments to date include: a) the procurement of the tubing and tubesheets, to the desired specifications; b) validation that the design base properties of VAR and ESR wrought products are well within the Code aceptable levels; and c) development of welding and tube-to-tubesheet inspection methods to provide satisfactory levels of quality.

35053 (GEFR-SP—070) **Heat transfer with hockey-stick steam generator.** Moody, E.; Gabler, M.J. (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). Nov 1977. Contract EY-76-C-03-1142;EY-76-C-03-1143. 29p. (CONF-780203—1). Dep. NTIS, PC A03/MF A01.

From 1. joint U.S./Japan LMFBR steam generator seminar; Tokyo, Japan (13 Feb 1978).

The hockey-stick modular design concept is a good answer to future needs for reliable, economic LMFBR steam generators. The concept was successfully demonstrated in the 30 Mwt MSG test unit; scaled up versions are currently in fabrication for CRBRP usage, and further scaling has been accomplished for PLBR applications. Design and performance characteristics are presented for the three generations of hockey-stick steam generators. The key features of the design are presented based on extensive analytical effort backed up by extensive ancillary test data. The bases for and actual performance evaluations are presented with emphasis on the CRBRP design. The design effort on these units has resulted in the development of analytical techniques that are directly applicable to steam generators for any LMFBR application. In conclusion, the hockey-stick steam generator concept has been proven to perform both thermally and hydraulically as predicted. The heat transfer characteristics are well defined, and proven analytical techniques are available as are personnel experienced in their use.

35054 (IWGFR—11) **Specialists meeting on high temperature structural design technology of LMFBRs, Champion, Pennsylvania, U.S.A., April 27-30, 1976. Summary report.** (International Atomic Energy Agency, Vienna (Austria). International Working Group on Fast Reactors). Oct 1976. 259p. (CONF-7604147—). Dep. NTIS (US Sales Only), PC A12/MF A01.

From Meeting on high temperature structural design technology of LMFBR's; Champion, PA, USA (27 Apr 1976).

Separate abstracts were prepared for each of the papers inclued.

35055 (IWGFR—11, pp 25-29) **Influence of creep-fatigue interaction on behaviour of type 304 stainless steel.** Breitling, H.; Grosser, E.D.; Lorenz, H. Oct 1976.

From Meeting on high temperature structural design technology of LMFBR's; Champion, PA, USA (27 Apr 1976).

In Specialists meeting on high temperature structural design technology of LMFBRs, Champion, Pennsylvania, U.S.A., April 27-30, 1976. Summary report.

The influence of creep-fatigue interaction on creep and fatigue properties of the SNR-300 structural steel X 6 CrNi 1811 (similar to AISI 304 ss) has been studied. Specimens were either precrept and then fatigue loaded or prefatigued and then creep loaded. In a third type of test alternating creep fatigue loading was applied. Tests were terminated when rupture occured. The results were evaluated with respect to the validity of a linear creep-fatigue damage rule as specified in ASME CC 1592. The values determined for the damage factor D show a relatively large scatter and depend on the type of test and the relative amounts of creep and fatigue loading. Alternating loading is most damaging with respect to specimen lifetime. An evaluation of the data shows that the values given in ASME CC 1592 can be regarded as representing a lower bound of creep-fatigue interaction effects.

35056 (IWGFR—11, pp 75-80) **CEASEMT system of finite element computer programs - use for inelastic analysis in liquid metal cooled reactor components.** Jeanpierre, F.; Charras, T.; Goldstein, S.; Hoffmann, A.; Livolant, M.; Roche, R. Oct 1976.

From Meeting on high temperature structural design technology of LMFBR's; Champion, PA, USA (27 Apr 1976).

In Specialists meeting on high temperature structural design technology of LMFBRs, Champion, Pennsylvania, U.S.A., April 27-30, 1976. Summary report.

The system of finite element computer programs CEASEMT is described. Such a system is used to perform inelastic analysis in liquid metal cooled reactor components. The model for non-elastic strains is explained in some detail.

35057 (IWGFR—11, pp 106-111) **Comparison of two approximate analyses of piping systems in a state of creep.** Johnstone, T.L. Oct 1976.

From Meeting on high temperature structural design technology of LMFBR's; Champion, PA, USA (27 Apr 1976).

In Specialists meeting on high temperature structural design technology of LMFBRs, Champion, Pennsylvania, U.S.A., April 27-30, 1976. Summary report.

Two approaches to study the state of creep of piping system in LMFBR type reactors are compared: The Kachanov approach (it is assumed that all stresses in the system will relax in the same manner) and the Spence approach.

35058 (IWGFR—11, pp 70-74) **Inelastic piping flexibility analysis. A beam type method.** Roche, R.L.; Hoffmann, A. Oct 1976.

From Meeting on high temperature structural design technology of LMFBR's; Champion, PA, USA (27 Apr 1976).

In Specialists meeting on high temperature structural design technology of LMFBRs, Champion, Pennsylvania, U.S.A., April 27-30, 1976. Summary report.

The principle and the simple formulation of a beam type method for inelastic piping flexibility analysis is outlined.

35059 (IWGFR—11, pp 169-171) **Test facility for large-diameter bellows.** Schallar, K.H. Oct 1976.

From Meeting on high temperature structural design technology of LMFBR's; Champion, PA, USA (27 Apr 1976).

In Specialists meeting on high temperature structural design technology of LMFBRs, Champion, Pennsylvania, U.S.A., April 27-30, 1976. Summary report.

This paper reports on the CADARACHE Test facilities for large diameter bellows for sodium cooled fast breeder reactors.

35060 (IWGFR—11, pp 58-64) **Analysis for out of plane bending on curved pipes in creep: Development of method and design factors.** Spence, J.; Boyle, J. Oct 1976.

From Meeting on high temperature structural design technology of LMFBR's; Champion, PA, USA (27 Apr 1976).

In Specialists meeting on high temperature structural design technology of LMFBRs, Champion, Pennsylvania, U.S.A., April 27-30, 1976. Summary report.

The aim is to study the out of plane bending of a curved pipe in creep. The current situation in elasticity, and the state of research into the creep of piping components, are briefly reviewed. The ultimate goals of the analysis of curved pipes under combined loading is discussed with the conclusion that, from the point of view of system analysis, it is more expedient to calculate an "energy factor" rather than the classical "flexibility factor". An approximate energy based analysis is presented which utilises a simple power law of creep and direct optimisation methods on a computer. Results for various material and geometric parameters are presented.

35061 (IWGFR—11, pp 7-24) **Exploratory testing in support of constitutive equation development for inelastic analysis.** Swindeman, R.W.; Klueh, R.L. Oct 1976.

From Meeting on high temperature structural design technology of LMFBR's; Champion, PA, USA (27 Apr 1976).

In Specialists meeting on high temperature structural design technology of LMFBRs, Champion, Pennsylvania, U.S.A., April 27-30, 1976. Summary report.

This paper describes some of the significant inelastic behavioral features of type 304 stainless steel and of 2 1/4 Cr-1 Mo steel as observed from uniaxial exploratory mechanical testing. Exploratory tests of reference heats of type 304 stainless steel reveal that the initial yield strength is quite low, the work-hardening capability under both monotonic and cyclic straining is high, and the strain rate effects are almost negligible in the temperature range 400 to 600°C (752 to 1112°F). The influence of low stress creep exposure on the subsequent flow stress is of a hardening nature for the conditions of interest. The creep behaviour can be characterized as exhibiting pronounced creep hardening with minimal time-dependent recovery. Depending upon the specific test conditions, plasticity strain can either suppress or accelerate subsequent creep rates. Exploratory tensile and strain-cycling tests on annealed 2 1/4 Cr-1 Mo steel reveal that this material has a relatively high yield strength, low work-hardening capability, and significant response to different strain rates in the temperature range 300 to 600°C (572 to 1112°F). Exposure to low stress creep conditions can produce a loss in the hardening capability. The creep bahaviour can be characterized as exhibiting modest creep hardening under low stress conditions but time-dependent recovery can be significant. As with the austenitic steels, plastic strain can either suppress or accelerate creep rates.

35062 (IWGFR—11, pp 112-121) **Considerations for weldment design for elevated temperature applications.** Wei, B.C. Oct 1976.

From Meeting on high temperature structural design technology of LMFBR's; Champion, PA, USA (27 Apr 1976).

In Specialists meeting on high temperature structural design technology of LMFBRs, Champion, Pennsylvania, U.S.A., April 27-30, 1976. Summary report.

Because of the scarcity of data and because of the metallurgical and structural complexity of the weldments, current design practice does not generally take detailed account of the behaviour of the weldments, either in terms of criteria limits or in terms of deformation behaviour of weldments into structural analyses. Rather, careful consideration is given to the type and location of welds, to weld materials and to examination of welds; and reliance is placed on the factor of safety used in deriving stress limits from base metal properties to guard against failure of welds. In some cases, such as the K-stress indices factors given in Section III of the ASME code for piping and piping components, determination of these constants are based, in part, on fatigue tests of welded pipe joints. Experience has shown that this approach is adequate at subcreep temperatures where design stress limits are, for the most part, intended to prevent gross inelastic deformation.

35063 (IWGFR—11, pp 29-36) **Some aspects of the CEA investigations on the mechanical behaviour of 316 steels in the medium temperature range.** Weisz, M. Oct 1976.

From Meeting on high temperature structural design technology of LMFBR's; Champion, PA, USA (27 Apr 1976).

In Specialists meeting on high temperature structural design technology of LMFBRs, Champion, Pennsylvania, U.S.A., April 27-30, 1976. Summary report.

This document deals with the creep behaviour under variable stress of 316 steels. It reports results on the primary circuit welds for PHENIX (stress and strains).

35064 (IWGFR—11, pp 196-207) **Static and cyclic testing of a PFR secondary circuit pipe bend.** Boulton, C.F. Oct 1976.

From Meeting on high temperature structural design technology of LMFBR's; Champion, PA, USA (27 Apr 1976).

In Specialists meeting on high temperature structural design technology of LMFBRs, Champion, Pennsylvania, U.S.A., April 27-30, 1976. Summary report.

This report describes tests carried out for the United Kingdom Atomic Energy Authority on specimens fabricated from stainless steel pipes and bends. The specimens were full-size replicas of a particular section of the secondary sodium pipework of the prototype fast ractor (PFR) at Dounreay. The specimens were tested under out-of-plane bending, simulating the loading experienced in the reactor under service conditions. The main object of the tests was to determine the onset of incipient buckling under various conditions of loading and temperature. Fatigue tests were carried out entirely at elevated temperature under a strain spectrum simulating the thermal cycling of the pipework in service. The tests have provided sufficient data to validate the stability and fatigue strength of the pipework under thermal loading.

35065 (IWGFR—11, pp 134-169) **Some aspects of high temperature structural design on LMFBR system and components.** Cesari, F.; Cecchini, F.; Labanti, M. Oct 1976.

From Meeting on high temperature structural design technology of LMFBR's; Champion, PA, USA (27 Apr 1976).

In Specialists meeting on high temperature structural design technology of LMFBRs, Champion, Pennsylvania, U.S.A., April 27-30, 1976. Summary report.

A series of tests has been carried out to study thermal and mechanical properties of LMFBR structural materials and components. Testing facilities are described and their specifications are given. Computer codes for analysis of experimental results are used.

35066 (IWGFR—11, pp 171-196) **Recent efforts of PNC on creep-fatigue, creep-buckling and thermal ratchetting of the LMFBR primary coolant system components.** Nagata, T.; Imazu, A. Oct 1976.

From Meeting on high temperature structural design technology of LMFBR's; Champion, PA, USA (27 Apr 1976).

In Specialists meeting on high temperature structural design technology of LMFBRs, Champion, Pennsylvania, U.S.A., April 27-30, 1976. Summary report.

A series of tests has been carried out to study elastic-plastic-creep behaviors of the model structures of the primary coolant piping components under some monotonic or cyclic loading and to investigate creep-buckling properties of the structures caused by accumulated creep strains under monotonic loading or to investigate their creep fatigue interactions under cyclic loadings and thermal ratcheting properties. Outlines of test rigs that are used for the tests, test procedures, test results and future test programs are presented.

35067 (IWGFR—11, pp 245-246) **Methods of analysis in the structural design of LMFBR components - French practice.** Schaller, K.H. Oct 1976.

From Meeting on high temperature structural design technology of LMFBR's; Champion, PA, USA (27 Apr 1976).

In Specialists meeting on high temperature structural design technology of LMFBRs, Champion, Pennsylvania, U.S.A., April 27-30, 1976. Summary report.

The method of analysis in the structural design of LMFBR components performed by the French Atomic Energy Commission at Cadarache are outlined.

35068 (IWGFR—11, pp 65-69) **Inelastic thermal transient analysis of tubesheets.** Sumikawa, M.; Shibato, E.; Shimizu, T.; Kusumoto, S. Oct 1976.

From Meeting on high temperature structural design technology of LMFBR's; Champion, PA, USA (27 Apr 1976).

In Specialists meeting on high temperature structural design technology of LMFBRs, Champion, Pennsylvania, U.S.A., April 27-30, 1976. Summary report.

In this paper the following topics are treated: Models to calculate the metal temperature distribution in tubesheets and analysis of inelastic thermal transients.

35069 (IWGFR—11, pp 81-85) **Simplified methods of analysis.** Townley, C.H.A. Oct 1976.

From Meeting on high temperature structural design technology of LMFBR's; Champion, PA, USA (27 Apr 1976).

In Specialists meeting on high temperature structural design technology of LMFBRs, Champion, Pennsylvania, U.S.A., April 27-30, 1976. Summary report.

A simplified method to predict the stress levels and strain ranges for the design of fast reactor components is presented.

35070 (KFK—1277/1) **1st quarterly report 1977.** (Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Schneller Brueter). Jun 1977. vp. (In German). Dep. NTIS (US Sales Only), PC A09/MF A01.

The present report describes the activities carried out in the 1st quarter of 1977 at the Gesellschaft fuer Kernforschung in Karlsruhe or on its behalf in the framework of the fast breeder project (PSB). The problems and main results of the partial projects fuel rod development, materials testing, reactor physics, reactor safety and reactor technology are presented.

35071 **Methodology of the FBTR dynamics code.** Kumar, A.; Kumar, S.S. (Indian Inst. of Tech., Bombay. Dept. of Electrical Engineering). pp 192-204 of Proceedings of the symposium on power plant dynamics and control. Bombay; Department of Atomic Energy (1976).

From Symposium on power plant dynamics and control; Bombay, India (23 Feb 1976).
See CONF-760265—.
The dynamics code of FBTR describes the neutronic, thermal and hydraulic behaviour of the reactor plant in response to plant incidents like pump failure, loss of grid, scram etc. The mathematical and computational models used in this code have been compiled and are presented. The reactor plant consists of the reactor, intermediate heat exchanger, steam generator and the associated piping and pumps. The kinetic behaviour of the reactor is simulated by the usual point reactor and zero prompt neutron life-time approximations. The thermal and hydraulic behaviour is studied by dividing the reactor into five radial and five axial zones. The once through steam generator is divided in 90 mesh points and at each point a set of partial differential equations is used to account for the mass, momentum and energy balance. A brief account of the numerical solutions is given.

35072 (ORNL—5309, pp 261-265) **Nondestructive testing.** Smith, J.H. Nov 1977.
In Liquid Metal Fast Breeder Reactor Materials Development Program. Quarterly progress report for period ending March 31, 1977.
Development of an ultrasonic inspection technique for the weld and weld interfaces in dissimilar-metal transition joints is discussed. Work involving alloy 800, stainless steels 304 and 316, and 2¼ Cr—1 Mo is described. Frequency shifts were noted for some of the materials. 2 figures. (RWR)

35073 (ORNL—5369) **Long-range program plan for high-temperature structural design.** (Oak Ridge National Lab., Tenn. (USA)). Dec 1977. Contract W-7405-ENG-26. 101p. .
The program described is concerned with developing and validating the high-temperature structural design technology required for breeder reactor components and with the effective transfer of that technology to component designers. The primary objective of the program is thus to establish, and transfer to designers, a rationally sound and experimentally verified high-temperature structural design technology that will assure freedom from structural failure. More specific objectives are: (1) To provide a technology for assuring that component designs will be both safe and reliable during their design lifetimes. (2) To provide the designer with improved methods, procedures, tools, and criteria that are more economical to apply, are not overly conservative, and will allow increased component design flexibility, thus resulting in better and cheaper component designs and, ultimately, in increased flexibility in plant design and operation. (3) To provide methods for better definition of design margins (against identified failure modes). (4) To experimentally verify and validate each aspect of the technology. (5) To improve reliability and confidence levels of component designs. (6) To provide design methods, and thus designs, that are more defensible. (7) To provide an improved technological basis for licensing.

35074 (TI—00-LME-023) **Summary of LMEC sodium valve operating history.** Snair, G.L.; Mirliss, G.; Dewart, W. (Liquid Metal Engineering Center, Canoga Park, Calif. (USA)). 14 Nov 1977. Contract EY-76-C-03-0700. 43p. .
LMEC/AI experience with valves for sodium service extend 27 years with many hundreds of thousands of valve service hours. A history of the sodium valves at the LMEC site from 1959 through 1971 was reported by Messers Freede and Thorel. A continuation of this history to the present is presented herein. History of the more than 450 sodium valves in use during this period from 1971 to the present has included refurbishing more than 50 valves. Of these 50, less than half have been failures, and the rest have been routine overhaul or design modification. During this span since 1971 fifteen new procurement contracts have been placed for a total of 230 sodium service valves. Four special sodium valve tests involving seven test valves have also been run since 1971.

35075 (TID—28259) **Prototype Large Breeder Reactor: Phase II follow-on final report. Executive summary.** (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Nov 1977. Contract EY-76-C-03-1141. 32p. .
An Executive Summary is presented of five reports pertaining to follow-on tasks which were assigned to Westinghouse Advanced Reactors Division at the end of Phase II of the PLBR studies. Although a decision was made in April 1977, to discontinue the PLBR studies and not to enter Phase III of the Program, the need to investigate a few outstanding issues prior to the end of FY 1977 was identified. Westinghouse ARD was assigned the following tasks: Task I—surveillance and in-service inspection; Task J—piping design and analysis; Task L-1—primary piping integrity-licensability; Task N—Sulzer cycle-system operation at start-up, shutdown and part-load; and Task O—plant simulation and control of superheat cycle. In parallel, Stone and Webster was assigned several tasks, for which they are issuing a separate report. A few of the tasks, such as the Surveillance and the Piping Design tasks, required some cooperation between the Westinghouse and the Stone and Webster teams, but most of the work was performed independently. The reports themselves are presented in a separate volume.

35076 **Thermal expansion worths for a liquid-metal fast breeder reactor inferred from small-sample reactivity measurements.** Wei-Teh Lee, B. (General Electric Co., Sunnyvale, CA); Kaiser, R.E.; Hitchcock, J.T.; Russell, C.S. *Nucl. Sci. Eng.;* **65**: No. 3, 429-440(Mar 1978).
An indirect experimental technique for determining the expansion coefficient was developed to provide uncertainty estimates for expansion coefficient calculations. This technique uses an R,Z reactivity worth map synthesized from small-sample reactivity traverse measurements for major materials over the reactor core and blanket regions. The experimentally based expansion coefficients, representing the reactivity change due to uniform axial and radial expansion, are deduced by appropriately integrating measured worth profiles. This technique was evaluated in Phase A of the Zero Power Plutonium Reactor Assembly 5. Direct calculations of the expansion coefficients were performed, and results were compared with the experimentally determined values. The validity of the technique used to derive expansion coefficients from worth measurements was evaluated. It is concluded that the total expansion coefficients are reasonably well calculated; however, the calculated radial expansion coefficient was overestimated. Sources of possible systematic errors in the experimentally based values were studied. Based on the present experiment, an uncertainty of +-20% (90% level of confidence) on expansion calculations using ENDF/B-III data is estimated for a clean core configuration.

35077 **Production of ^{232}U in a 1200-MW(e) liquid-metal fast breeder reactor.** Mann, F.M.; Schenter, R.E. (Hanford Engineering Development Lab., Richland, WA). *Nucl. Sci. Eng.;* **65**: No. 3, 544-547(Mar 1978).
Uranium-232 production has been calculated in a 1200-MW(e) liquid-metal fast breeder reactor as a function of position, time, and core composition. Whenever thorium is present in the core, large quantities of ^{232}U relative to uranium (approximately 1000 ppm) are generated. For ^{232}U generated in the blanket, production is on the order of 50 ppm.

35078 **Measurement of the ^{238}U Doppler effect in gas-cooled fast reactor critical assemblies.** Bhattacharyya, S.K.; Pond, R.B. (Argonne National Lab., IL). *Nucl. Sci. Eng.;* **65**: No. 3, 548-553(Mar 1978).
The Doppler effect of a small UO_2 sample was determined for the temperature range from 300 to 1100 K at the core center of the Argonne National Laboratory gas-cooled fast reactor (GCFR) critical assembly. The measurement provided the first data on the important ^{238}U Doppler effect in GCFR systems. The normalized value of the GCFR ^{238}U Doppler effect was found to be 54% smaller than the corresponding value in an equivalent liquid-metal fast breeder reactor (LMFBR) assembly. Calculations with ENDF/B-IV data yielded a calculated/experimental (C/E) ratio of 0.83, which is considerably lower than that in LMFBR assemblies. The reason for this misprediction appears to be an underprediction of the low-energy flux, a feature that seems to be general to hard spectrum assemblies. The ^{238}U Doppler effect was also determined in a "steam-flooded" GCFR assembly. The Doppler effect for the temperature range from 300 to 1100 K increased by 93% relative to the "dry" reference value because of spectral softening. The same calculational methods using ENDF/B-IV data resulted in the much better C/E value of 1.00.

35079 **Core exit instrumentation of the Clinch River Breeder Reactor Plant.** Carelli, M.D. (Westinghouse Electric Corp., Madison, PA). *Nucl. Technol.;* **37**: No. 3, 261-273(Mar 1978).
Assembly exit thermocouples are chosen for the Clinch River Breeder Reactor Plant as the instrumentation providing the most useful information at the minimum cost. One thermocouple is positioned at the exit of each fuel assembly and at approximately half of the radial blanket assemblies. The number of thermocouples, their positions, and characteristics are selected to satisfy the reactor control, surveillance, and design verification functions. The various uncertainties affecting the assemblies' coolant exit temperature measurements are quantitatively defined to correlate the measured temperature with the fuel rod design cladding temperature, which is the major parameter in determining the allowable fuel rod burnup and lifetime. Thus, appropriate factoring of thermocouple measurements allows the fuel assembly burnup to be increased quite significantly, with related cost savings of hundreds of millions of dollars. Due to the tremendous economic leverage on operating costs over the plant lifetime, close attention to proper instrumentation should be paid in the design of future commercial liquid-metal fast breeder reactors.

35080 **Elimination of transuraniun elements by burnup in a power fast breeder reactor.** Oliva, G. (Univ. of Rome); Palmiotti, G.; Salvatores, M.; Tondinelli, L. *Nucl. Technol.;* **37**: No. 3, 340-352(Mar 1978).

The elimination of transuranium (TRU) elements by neutron absorption has been investigated in an actual power liquid-metal fast breeder reactor (LMFBR) (of the Superphenix type). Special fuel elements containing TRU oxides were considered in different core locations. The effects on design parameters have also been evaluated. The results show that the advantages of TRU elimination by means of LMFBRs, compared with using a thermal reactor, consist mainly of the small perturbation of the integral properties and design parameters of the reactor for the large amount of TRU that can be introduced. However, from the point of view of the TRU transmutation reaction rates, thermal reactors seem to be better. The choice of a compromise between the variation of design parameters and the TRU amount to be transmutated depends on the actual reactor design.

35081 (ANL-Trans—1128) **Studies needed to prevent the use of expansion bends in LMFBR intermediate heat exchangers.** Kayser, G. (CEA Centre d'Etudes Nucleaires de Cadarache, 13 - Saint-Paul-les-Durance (France). Dept. des Reacteurs a Neutrons Rapides). Feb 1978. Translation of French Paper F7/11. Vol. 2: Reactor core coolant circuit, Part F. (CONF-750908—9). 11p. Dep. NTIS, PC A02/MF A01.

From 3. international conference on structural mechanics in reactor technology; London, UK (1 Sep 1975).

The LMFBR IHX built in France consists in a vertical tube bundle welded on 2 tube sheets. The secondary sodium flows down a central pipe to the lower collector then up through the tube bundle where it is heated. During the preliminary studies for the PHENIX reactor, it was soon evident that a structure with expansion bends on tubes would lead to prohibitive sheet-thickness. Moreover, the presence of bends increased the total length, made vibration problems more complicated, and, finally made the structure more expensive. Therefore, a solution with straight tubes was studied, and, despite the pressure and diameter increase, the Phenix sheets had the same thickness as Rapsodie's ones. Evidently, the solution of the problems raised by the presence of thermal stresses needed thorough studies and led to the following theoretical and experimental developments: (1) A computer code was written for structural analysis. The structure was divided in annular elements that could be studied by means of the elementary theory of shells and plates; and reduced elastic coefficients were given to the tube sheets to account for the presence of drilled holes. (2) An experimental study was undertaken to determine the reduced elastic coefficients of the tube sheets. (3) A computer code was written to study the primary sodium flow around the tube bundle, and experimental studies were made on a mockup, the fluid being water. (4) The results of the previous code were used to determine, by means of a code for thermal analysis, the temperature field in the bundle both in steady state and transient regimes. Up to now, many transients were performed and the Phenix heat exchangers have been operating quite satisfactorily; this seems to prove the design assumptions were correct.

35082 **Radiation behavior of vitreous silica.** Primak, W. (Argonne National Lab., IL). *Nucl. Sci. Eng.;* **65**: No. 1, 141-196(Jan 1978).

Several properties of vitreous silica relevant to application as an optical element in a reactor were studied, including density, refractive index, optical path, stress relaxation, and optical absorption. The irradiations were in fields characteristic of the fuel regions of several operating reactors and at temperatures up to 370°C. The radiation-induced changes in optical path are significant, but are much smaller than those in the density and refractive index because the last two are of opposite sign. The thermal coefficient of optical path causes changes of comparable magnitude. Optical absorption is not a serious matter in the upper end of the visible region.

35083 **Experimental investigation of neutrons streaming through the grid-plate shield of liquid-metal fast breeder reactors.** Uchida, S. (Hitachi Ltd., Igaraki, Japan); Kitamura, M.; Miyasaka, S. *Nucl. Sci. Eng.;* **65**: No. 1, 155-159(Jan 1978).

Experiments were undertaken to determine the distribution of neutron flux on the core support grid plate of liquid-metal fast breeder reactors by using a semimockup of the grid-plate shield consisting of carbon-steel and aluminum slabs. The experiments were calculated with a conventional calculational procedure containing the TRD-3 two-dimensional removal diffusion code. It was demonstrated that the calculated radial distribution of the fast neutron reaction rates of ^{115}In(n,n')/sup 115m/In agreed with the measured values within a factor of 2.

35084 **Scaling up the fast breeder.** *Nucl. Eng. Int.;* **22**: No. 264, 68-69(Nov 1977).

A brief description is given of the British experience in operating the PFR at Dounreay and plans for scaling up the prototype to a commercial demonstration fast reactor (CDFR). Major components performed extremely well in Na. Experience with leaks in steam generators and superheaters has results in some design changes for CDFR. Comparison of main parameters shows that the larger output of CDFR is provided by a greater number of components so that extrapolation in component size is generally kept small. Lower temperature will reduce thermal stress problems, and will also allow the use of 9% Cr steel superheaters. Primary containment will be prestressed concrete. The problem of security in relation to transportation of Pu is discussed.

35085 **Maintaining an effective breeder reactor programme.** Beckjord, E.S. (Dept. Energy, (US) Division of Reactor Development). *Nucl. Eng. Int.;* **22**: No. 264, 55-57(Nov 1977).

The near-term and long-term objectives of the US advanced nuclear programme are summarised and the Non-Proliferation Alternative System Assessment Program (NASAP) is discussed. US work on the sodium breeder is being restructured to examine alternate fuel cycles which minimise or eliminate the use of Pu. The test facilities and areas of technology involved are considered.

35086 **Performance of an electromagnetic temperature sensor in liquid sodium.** Farrington, B.J.; Hughes, G. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). *J. Br. Nucl. Energy Soc.;* **16**: No. 4, 347-352(Oct 1977).

An electromagnetic temperature sensor has been evaluated in flowing sodium. Temperature fluctuations, produced by the injection of a hot stream of sodium into the main sodium flow, have been measured with the sensor and compared with the indications of a small-diameter thermocouple. These comparisons show that a directly immersed sensor is capable of detecting 0.1 degC root-mean-square temperature oscillations with a 20 db signal-to-noise ratio, and enable the temperature sensitivity of the sensor to be determined. The sensor has also been operated from within a stainless steel pocket at reduced sensitivity (approximately 40% of the directly immersed value). In this operational mode the measured sensitivity agrees closely with that predicted by a developed theoretical analysis technique.

35087 **Safety and reliability: analyses of a breeder reactor.** Fussell, J.B.; Cate, C.L.; Wagner, D.P. (Univ. of Tennessee, Knoxville). *Simulation;* **29**: No. 4, 121-124(Oct 1977).

A University of Tennessee independent study of the safety and reliability of the Clinch River Breeder Reactor Plant in Oak Ridge, Tennessee is described. The study uses several kinds of models, and analytical computer programs, one of which (BACFIRE) is briefly described and illustrated.

35088 **Determination of the bending loadings resulting from the superheated steam flow path variation in an expansion pipe-bend for sodium-water heat exchangers.** Crucitti, N. (Ansaldo S.p.A., Genoa (Italy)). *Energ. Nucl. (Milan);* **24**: No. 6, 327-334(Jun 1977).

The structural design of an asymmetric stiffened pipe incorporating an expansion bend, as applied in a sodium-water heat exchanger, was presented in Energi Nucleare, vol. 23(10) p. 507 (October 1976). The present article describes a further theoretical approach required to make such design more complete and reliable. In particular, the bending loadings exerted on the pipe-bend, as resulting from the path variation of the running fluid, are evaluated. All correlations associated to such loadings are derived in terms of the expansion bend sizing parameters and superheated steam flow properties and presented in a quick-use form for practical design purposes.

35089 **Sodium vapor deposition onto a horizontal flat plate above liquid sodium surface. II. Analysis of sodium vapor deposition rate with sodium mist growth within main flow region.** Kudo, K. (Hitachi Ltd., Ibaraki (Japan). Hitachi Research Lab.); Hirata, Masaru. *Nippon Kikai Gakkai Rombunshu;* **43**: No. 368, 1407-1417(Apr 1977). (In Japanese).

The sodium vapor deposition onto a horizontal flat plate above liquid sodium surface was studied. The analysis was performed by assuming that the sodium mist is emitted into the main flow without condensation and then grows up in the main flow and drops on the sodium surface. The effects of growth of sodium mist to the system were investigated. The model of the phenomena is the sodium deposition onto a horizontal flat plate which is placed above the sodium surface with the medium cover gas. One-dimensional analysis can be done. The rate of deposition is greatly reduced when the temperature of the flat plate is lowered. For the analysis of this phenomena, it is assumed that the sodium mist grows by condensation. One of results is that the real state may be the state between the state that the condensation of mist is made in the boundary layer and the state that the mist is condensed in the main flow. Others are that there is no effect of sodium mist condensation on the rate of deposition, and that the rate of the vaporization of sodium is given by the original and the modified model.

35090 **Small leak detection by measuring surface oscillation during sodium-water reaction in steam generator.** Nei, H.; Hori, M. (Power Reactor and Nuclear Fuel Development Corp., Oarai, Ibaraki (Japan). Oarai Engineering Center). *J. Nucl. Sci. Technol. (Tokyo);* **14**: No. 3, 200-209(Mar 1977).

Small leak sodium-water reaction tests were conducted to develop various kinds of leak detectors for the sodium-heated steam generator in FBR. The super-heated steam was injected into sodium in a reaction vessel having a sodium free surface, simulating the steam generator. The level gauge in the reaction vessel generated the most reliable signal among detectors, as long as the leak rates were relatively high. The level gauge signal was estimated to be the sodium surface oscillation caused by hydrogen bubbles produced in sodium-water reaction. Experimental correlation was derived, predicting the amplitude as a function of leak rate, hydrogen dissolution ratio, bubble rise velocity and other parameters concerned, assuming that the surface oscillation is in proportion to the gas hold-up. The noise amplitude under normal operation without water leak was increased with sodium flow rate and found to be well correlated with Froud number. These two correlations predict that a water leak in a "MONJU" class (300 MWe) steam generator could possibly be detected by level gauges at a leak rate above 2 g/sec.

35091 (KFK-tr—536) **Experimental results with carbide fuel rods in the BOR-60 reactor.** Tsykanov, V.A.; Gryazev, V.M.; Davydov, E.F.; Kuz'min, V.I.; Maiershin, A.A.; Syuzev, V.N.; Golovnin, I.S.; Men'shikova, T.S.; Bibilashvili, Yu.K.; Kotel'nikov, R.B. Translated from *At. Energ. (USSR);* **42**: No. 5, 378-382(1977). 17p. (In German). Dep. NTIS (US Sales Only), PC A02/MF A01.

Translated from Russian: Rezul'taty ispytaniya v reaktore BOR-60 tvelov s karbidnym toplivom.

In recent research work, much attention has been paid to the study of carbide fuels for fast power reactors, which have a better thermal conductivity and a larger number of heavy atoms than conventional oxide fuels. This is due to the fact that they may help to shorten the doubling time, to increase the breeding rate and thus to improve the efficiency of fast reactors. The present paper gives some results of a study on the behaviour of irradiated carbide fuels and fuel rods which had been in constant operation in the BOR-60 reactor up to a burnup of 10% of the heavy atoms.

35092 Leak detection of steam or water into sodium in steam generators of liquid-metal fast breeder reactors. Hans, R.; Dumm, K. (Internationale Atomreaktorbau G.m.b.H. (INTERATOM), Bergisch Gladbach (Germany, F.R.)). *At. Energy Rev.;* **15**: No. 4, 611-699(1977).

The leakage of water or steam into sodium in LMFBR steam generators, including a study of how leaks are detected and located as well as the potential damage that could be caused by such leaks, is surveyed. The most interesting steam generator designs evolving in those countries that develop and construct LMFBRs are presented. The relevant protection measures are described. Fault conditions are defined and descriptions given of possible sequences of events leading to abnormal conditions in a steam generator. Taking into account theory, the potential of the hydrogen and oxygen detection systems is discussed. Different hydrogen and oxygen detection systems are fully described. In so far as interesting technical solutions are concerned, previously developed devices have also been taken into account. The way oxygen detection supplements hydrogen detection is described by listing the available oxygen measuring devices and the relevant theory. Only a few sonic and accelerometer measurements have been made on complete steam generator units so there is little system data available. Descriptions, however, have been included to give the state of the art achieved for the sensors and the achieved sensitivities or band widths. The potential of this monitoring method is made evident by adding the technical data of the sensors. Furthermore, the available systems for monitoring medium and large leakages are described. Finally, recommendations are made concerning steam generator development and the application of hydrogen and oxygen detection systems, as well as acoustic measuring methods for small-leakage detection.

35093 Flow in the inlet plenum feature model of the Clinch River Breeder Reactor. McConnell, P.M. (Westinghouse Hanford Co, Richland, Wash). *Am. Soc. Mech. Eng., [Pap.];* **77-WA/FE-19**: vp(1977).

Results of the Inlet Plenum Feature Model (IPFM) hydrodynamic design verification tests are presented. The IPFM models all hydrodynamically important wetted surfaces in a full 360° (one quarter scale) sector of the inlet plenum and lower internal components of the Clinch River Breeder Reactor (CRBR). These tests were aimed at establishing a near optimum inlet plenum configuration; determining the fluid dynamic performance of the current CRBR auxiliary flow port liner design; evaluating the susceptibility of the inlet plenum design to flow blockage from various types of hypothetical debris; and assessing the ability of the inlet plenum to break up hypothetical bubbles injected into the inlet piping. The test results indicate that the CRBR inlet plenum will produce flow maldistributions of less than $plus or minus$ 3 percent and that mixing of the liquid sodium coolant will not be appreciably affected by substantial changes in the plenum height or the reactor flow rate. 16 refs.

35094 Effect of steam cut-off in FBTR deaerator. Raju, C.; Kumar, S.S. (Reactor Research Centre, Kalpakkam (India). Fast Breeder Test Reactor Design Group). pp 155-165 of Proceedings of the symposium on power plant dynamics and control. Bombay; Department of Atomic Energy (1976).

From Symposium on power plant dynamics and control; Bombay, India (23 Feb 1976).

See CONF-760265—.

The FBTR deaerator is fed with steam from the first bleeding stage of the turbine and alternatively with live-steam from the steam generator. In the unusual event of loss of supply from both these sources, supply can be resumed only by starting the auxiliary boiler. During this interval, the pressure in the deaerator decays and the pressure differential across the trays increases many-fold over that existing at normal load. The process dynamics calculations for this incident and the effects of steam hold-up in the the deaerator and the progressive cooling of the incoming condensate are described.

35095 Restraints for operation of FBTR steam generator. Vaidyanathan, G.; Kumar, S.S. (Reactor Research Centre, Kalpakkam (India). Fast Breeder Test Reactor Design Group). pp 144-154 of Proceedings of the symposium on power plant dynamics and control. Bombay; Department of Atomic Energy (1976).

From Symposium on power plant dynamics and control; Bombay, India (23 Feb 1976).

See CONF-760265—.

The sodium-heated once-through steam generator is a key component of FBTR plant. A compilation is presented of the restraints placed on the operation of the steam generator in static and dynamic conditions. These restraints arise from the corrosive potential of sodium and water, static and dynamic oscillations, thermal stresses, fluctuations of the nucleate boiling to film boiling transition point, loss of grid etc. The basic factors characterising these phenomena are discussed.

POWER REACTORS, AUXILIARY, MOBILE, PACKAGE, AND TRANSPORTABLE

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REGULATION AND LICENSING

35096 (RDT-E—6-1T(10-77)) **Near-isotropic petroleum-coke based graphites for high temperature gas-cooled reactor core components.** (Department of Energy, Washington, D.C. (USA). Div. of Nuclear Power Development). Oct 1977. Contract W-7405-ENG-26. 36p. .

The standard covers procurement requirements for extruded graphite logs, 15 in. (381 mm) or greater in diameter, manufactured with near-isotropic petroleum cokes and coal-tar pitch binders which are candidates or reference materials for replaceable fuel and reflector blocks for High-Temperature Gas-Cooled Reactors (HTGRs). The requirements are designed to produce the degree of lot-to-lot reproducibility which is required to ensure consistent and predictable properties and irradiation performance for specific graphite grades and to ensure traceability of the graphite logs to production processes and raw materials that affect performance. The standard is intended for use in the procurement of developmental and commercial grades of nuclear graphite which are to be evaluated on Department of Energy (DOE) funded programs for use as core components in HTGRs.

35097 Economics and potential use of low-temperature nuclear heat. Oesterwind, D. (Kernforschungsanlage Julich GmbH, Ger.). *Nucl. Technol.;* **38**: No. 1, 11-18(Apr 1978).

The economic security of the future energy supply requires the introduction of new energy technologies. The reason is the gradual exhaustion of the fossil energy carriers and the fossil emissions. In countries with population density, district heating is advantageous. For reasons of economical convenience and the conservation of fossil energy reserves, nuclear district heat coupling is better than fossil district heat coupling. District heat can provide the industry only with approximately 200°C; therefore, the potential of district heat in the residential and commercial sectors of consumption is larger than in industry. High-temperature reactors enable the expansion of the central supply of energy by using district heat and/or synthetic gas.

35098 Fast breeder licensing: is it unconstitutional. Full text of the press statement by the Upper Administrative Court at Muenster. *Atomwirtsch., Atomtech.;* **22**: No. 9, 454(Sep 1977). (In German).

The statement on the decision to wait for a decision of the Federal Constitutional Court on whether paragraph 7 of the Atomic Energy Act is compatible with the Basic Law is discussed.

35099 Nuclear power station verdicts in the Freiburg administrative court and the Wuerzburg administrative court in March 1977. Haeusler, D. (Vereinigung Deutscher Elektrizitaetswerke e.V. (VDEW), Frankfurt am Main (Germany, F.R.)). *Elektrizitaetswirtschaft;* **76**: No. 19, 673-675(Sep 1977). (In German).

The verdicts which followed in rapid sequence by the Freiburg Administrative Court on the 14th March 1977 in the dispute about the Wyhl nuclear power station, and by the 25th March concerning the dispute about the Grafenrheinfeld nuclear station have attracted special interest because of their controversial judgements on the requirement for a 'burst-protection'. But they also demonstrate in the further decisions and their bases that there are still many legal questions in atom law which have not yet been made absolutely clear. The author attemps to show points of agreement and of antithesis in the verdicts, and adopts an attitude.

REACTOR DOCKETS

35100 (DOCKET-50259—1204) **Browns Ferry Nuclear Power Station, Units 1, 2, and 3. Annual operating report: 1 January—31 December 1977.** (Tennessee Valley Authority, Chattanooga (USA)). 28 Feb 1978. vp. (DOCKET-50260—949; DOCKET-50296—651).

The three reactors operated at near full power generating 17,622,500 MWH gross electrical power. There were 153 major power reductions including 50 scrams mostly caused by equipment failures. Data are presented concerning operations, modifications, occupational exposures, effluent activity, and waste disposal. (FS)

35101 (DOCKET-50280—936) **Surry Power Station, Units 1 and 2. Annual operating report: January—December 1977, volume I—introduction, summary of operating experience; changes, tests, experiments, and safety-related maintenance; effluent releases; data tabulations.** (Virginia Electric and Power Co., Richmond (USA)). 1978. vp. (DOCKET-50281—850).

A chronological operating sequence including shutdowns and occurrences during the year which required load reductions or resulted in non-load related incidents is given. Data are presented concerning plant and procedure changes, tests, experiments, safety related maintenance, effluent releases and personnel radiation exposures. (FS)

ECONOMICS

35102 Summary of US activities in low-temperature reject heat utilization. Witzig, W.F. (Pennsylvania State Univ., University Park); DeWalle, D.R. *Nucl. Technol.;* **38**: No. 1, 25-34(Apr 1978).

A summary is presented of the research programs in the U.S. that have studied the utilization of reject heat from both fossil and nuclear power plants. The results of over 80 investigators are presented in two areas. The first area is soil warming, greenhouses, and warm water irrigation. The second area is aquaculture and integrated systems. The present status of this research indicates that technical feasibility for the utilization of reject heat is at hand. Many problems, such as institutional, regulations, land use, and the coupling of heat source to heat utilization systems, exist.

35103 (GA-A—14848) **Analysis of nuclear systems satisfying U.S. energy needs.** Turner, R.F.; Brogli, R.H.; Ligon, D.M.; Hamilton, C.J. (General Atomic Co., San Diego, Calif. (USA)). Feb 1978. Contract EY-76-C-03-0167-065. 35p. Dep. NTIS, PC A03/MF A01.

A number of strategies for the development of nuclear power in the U.S. over the next 50 to 60 years have been studied systematically. These strategies have been evaluated with reference to four vital criteria: (1) limiting the proliferation of nuclear weapon materials, (2) limiting uranium ore consumption, (3) favorable power costs, and (4) preserving alternatives for assuring a very long term nuclear energy supply to the nation.

35104 (INIS-mf—3900) **Outlooks of nuclear power in Belgium.** Jaumotte, A. (American Nuclear Society, Mol (Belgium). Belgian Section). 1976. 14p. (In French). (CONF-7606173—3). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Meeting of the Belgian section of the American Nuclear Society; Mol, Belgium (17 Jun 1976).

The final report of the assessment commission for nuclear power is discussed. The pattern of Belgian demand for the next decade growing rates is examined with a particular focus on the economics, safety, pollution, uranium resources and enrichment, reprocessing and waste disposal.

35105 (INIS-mf—3901) **Financing aspects of the investments for the construction of a nuclear power program.** Maldague, R. (American Nuclear Society, Mol (Belgium). Belgian Section). 1976. 15p. (In French). (CONF-7606173—1). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Meeting of the Belgian section of the American Nuclear Society; Mol, Belgium (17 Jun 1976).

The development of the nuclear power in Belgium till 1990 and the necessary investments at different discount rates are evaluated. The financial aspects and different solutions are considered.

35106 Nuclear energy: where it stands. Weber, R. *Bull. Schweiz. Elektrotech. Ver.;* **68**: No. 19, 998-1008(1 Oct 1977). (In German, French).

A summary report is presented of the conference of the IAEO in Salzburg, May 1977. Comprehensive statistical information is given. The topics discussed include: energy prognoses, nuclear energy programs, uranium enrichment and the French initiative, nuclear fuel reprocessing, waste solidification, transmutation, permanent disposal, global radiation burden, reactor security, public opposition, nuclear non-specialists and non-nuclear specialists, the developing countries and nuclear energy.

35107 Development of new technologies for energy production in the Federal Republic of Germany. Schmidt-Kuester, W.J.; Wagner, H.F. *Brennst.-Waerme-Kraft;* **29**: No. 9, 377-383(Sep 1977). (In German).

In the introduction, this survey of the development of new energy technologies emphasises the importance of the nuclear energy in view of its short-term availability. Then the relevant developments for the medium- und lang-term availability for covering the energy demand are presented, and especially the thermal application of solar energy is dealt with. R and D work for the electrical use of wind and waves energy, of sea currents and hydro power, and others, are described. In the area of developing the rational use of energy, the authors refer particularly to the practical techniques of application in households and other small users, as well as to the power and heating coupling in connection with district heating. A survey of the present stage and activities in respect of development of controlled nuclear fusion concludes the article.

35108 VDEW meeting in Munich. *Elektrizitaetswirtschaft;* **76**: No. 12, 365-370(Jun 1977). (In German).

From VDEW meeting; Muenchen, Germany, F.R. (24 May 1977).

Report on the annual meeting of the Vereinigung deutscher Elektrizitaetswerke, held in Munich in May 1977. The main meeting with the lectures by Juergen Ponto and Edward Teller is dealt with in detail.

35109 Compared energy policies of France, England and Germany. II. Electricity and nuclear energy. de Carmoy, G. *Rev. Energ.;* **28**: No. 294, 319-326(May 1977). (In French).

Electrical and electronuclear policies of France, Great Britain and Germany are examined. The following aspects are considered: options and realizations until 1974-1975; revision of production objectives for 1985; research and development of advanced-type reactors; fuel cycle management.

35110 Future perspectives of energy supply. Pt. 1. Situation analysis and demand forecasts. Grathwohl, M. *Naturwiss. Rundsch.;* **30**: No. 2, 46-52(Feb 1977). (In German).

The economic and political dependence of the western industrial countries resulting from the primary energy demand, in particular the petroleum and natural gas demand, is obvious, and in the long run fatal. Furthermore, this article shows that the fossil energy carriers petroleum and natural gas can only meet the demand for a period which is that short that all efforts ought to be made to develop alternative solutions to meeting the demand.

CONSTRUCTION AND OPERATION

35111 Continuing role for the engineer/constructor. Brush, H.H. (Bechtel Power Corp., San Francisco, Calif. (USA)). *Nucl. Eng. Int.;* **22**: No. 264, 64-66(Nov 1977).

Licensing reform is needed to reduce capital and schedule cost, and practical and economical standard designs require flexibility in approach and licensing philosophy. Apart from coordinating and managing multi-disciplinary efforts during design and construction, engineer/constructors are active in investigating and applying ways for improving the operating availability of nuclear plants.

FUEL CYCLE

35112 Optimization of material flow in the nuclear fuel cycle using a cyclic multi-stage production-to-inventory model. DePorter, E.L. Blacksburg, VA; Virginia Polytechnic Inst. and State Univ. (1977). 204p. University Microfilms Order No. 78-01,578.

Thesis (Ph. D.).

The nuclear fuel cycle is modelled as a cyclic, multi-stage production-to-inventory system. The objective is to meet a known deterministic demand for energy while minimizing acquisition, production, and inventory holding costs for all stages of the fuel cycle. The model allows for cyclic flow (feedback) of materials, material flow conversion factors at each stage, production lag times at each stage, and for escalating costs of uranium ore. It does not allow

shortages to occur in inventories. The model is optimized by the application of the calculus of variations and specifically through recently developed theorems on the solution of functionals constrained by inequalities. The solution is a set of optimal cumulative production trajectories which define the stagewise production rates. Analysis of these production rates reveals the optimal nuclear fuel cycle costs and that inventories (stockpiles) occur in uranium fields, enriched uranium hexafluoride, and fabricated fuel assemblies. An analysis of the sensitivity of the model to variation in three important parameters is performed.

35113 Build-up and decay of actinide nuclides in fuel cycle of nuclear reactors. Tasaka, K.; Kikuchi, Y.; Shindoh, R.; Yoshida, H. (Jpn At Energy Res Inst, Ibaraki-ken). *J. Nucl. Sci. Technol. (Tokyo);* **14**: No. 7, 506-518(Jul 1977).

In order to assess the feasibility of utilizing plutonium in thermal reactors, build-up and decay of actinide nuclides have been studied for BWR, PWR, HWR, HTGR and LMFBR, which are uranium-oxide fueled or mixed-oxide fueled, and which produce electric power of 1,000 MW. Precautions should be taken against high activities of resultant actinides if plutonium is utilized as a fissile material for thermal reactors. It is recommended that a thermal reactor should be fueled with uranium, the plutonium produced in a thermal reactor should be used in a fast reactor, and plutonium produced in the blanket of a fast reactor is more appropriate as fast reactor fuel. 24 refs.

PROCESS HEAT REACTORS

REFER ALSO TO CITATION(S) 34689, 35269, 35270, 35310

35114 (AECL—5239) Role for nuclear energy in the recovery of oil from the tar sands of Alberta. Puttagunta, V.R.; Sochaski, R.O.; Robertson, R.F.S. (Atomic Energy of Canada Ltd., Pinawa, Manitoba. Whiteshell Nuclear Research Establishment). Dec 1976. 73p. Dep. NTIS (US Sales Only), PC A04/MF A01.

Techniques of oil recovery from the tar sands and the energy requirements of this operation are described. Fossil fuels, and CANDU reactors are examined as competitive sources of energy for the tar sands plants. The CANDU-OCR reactor appears to have the necessary flexibility to fit into many of the possible methods of recovering oil from the tar sands. Cost comparisons of fossil and nuclear sources show that, for the supply of process steam, the nuclear source is competitive under the criteria of debt financing or low discount rates on capital, continued escalation, and long plant capital write-off period.

35115 Low-temperature water reactor for the district heating atomic power plant. Skvortsov, S.A.; Sokolov, I.N.; Krauze, L.V.; Nikiporetz, Yu.G.; Philimonov, Y.V. (Inst. of Atomic Energy, Moscow). *Nucl. Technol.;* **38**: No. 2, 248-251(Apr 1978).

From Conference on low-temperature nuclear heat; Otaniemi, Finland (21 Aug 1977).

A natural convection low-pressure water reactor can be utilized as a source of district heating. This provides inherent safety factors under conditions requiring emergency core cooling. The reactor pressure vessel is contained within a prestressed concrete shell, both of which are designed to withstand accident overpressure. This also results in a relatively thin-walled reactor vessel that can be fabricated on-site. The overall safety and economy of such a system merits further consideration as a system for providing low-temperature nuclear heat for district heating.

35116 Optimization problems in a large nuclear heat-and-power plant connected to a developing district heating system. Marecki, J.; Krajeski, R.; Renski, A. (Technical Univ. of Gdansk, Poland). *Nucl. Technol.;* **38**: No. 1, 41-49(Apr 1978).

The development of district heating systems in Poland up to 1990 is characterized with particular reference to the combined generation of heat and electrical energy in fossil-fired and nuclear heat-and-power plants. The proposed method of an economic evaluation of nuclear heat-and-power schemes consists in comparing them with the equivalent fossil-fired plants and minimizing the total annual costs of heat energy generation. Hence, the optimum value of the so-called combination factor α can be obtained, this factor being defined as the ratio of heat output at the steam turbine outlets to the maximum heating load of the whole heat-and-power plant. As an example of the optimization procedure, three particular values of the maximum heating load Q/sub max/ in given areas are considered: Q/sub max/ = 1000, 1500, and 2000 MW, and in each case the optimum α values are determined.

35117 District heating in greater Stockholm. Jaederberg, L. (Stockholms Energiverk, Sweden). *Nucl. Technol.;* **38**: No. 1, 50-53(Apr 1978).

The Stockholm municipality and the Swedish State Power Board have entered into a collaboration on a nuclear combined district heating power station (NHPS) in Greater Stockholm. These municipalities and the state have jointly studied the future heat supply for Greater Stockholm and, in particular, the alternative based on heat from an NHPS. The investigations embrace an NHPS located in Greater Stockholm or at the Forsmark nuclear plant (future units 3, 4, and/or 5) and various alternatives in which Greater Stockholm is supplied with heat by expansion of oil-fired plants. Different technical solutions were taken into account--type of turbine, method of transporting hot water, various outgoing temperatures, etc.--and the alternatives have been evaluated on different assumptions regarding fuel prices, investment costs, energy forecasts, and continued nuclear power expansion. The investigations show that district heating and combined district heating power stations will expand in the region. If the relation of costs between nuclear and oil power continues, the investigations indicate lower total annual costs of oil-based systems than systems based on an NHPS. This conclusion is valid even if the oil price should increase approximately 50%, provided that the number of nuclear power units is independent of whether or not they are used for district heating. But if the heat extracted from the station implies that the number of nuclear power units may be increased, the best nuclear alternative will be more economical than the best oil-fired alternative.

35118 Investigations concerning nuclear energy in the combined production of electricity and heat in the Helsinki metropolitan area. Aho, M. (Helsinki Electricity Works); Hiidenpalo, H.; Seppae, M.; Tiainen, O.J.A. *Nucl. Technol.;* **38**: No. 1, 54-61(Apr 1978).

The possibility of producing the base load of both electricity and district heat for the Helsinki Metropolitan Area (HMA) utilizing nuclear energy has been investigated since 1968. At every stage of the study, it has been concluded that district heating utilizing nuclear power in combined electricity and heat productions is the most economical way of heating the main part of the HMA. The studies have dealt with the economy of energy production and heat transmission as well as nuclear safety. According to the latest results, the optimum of the heat output of a 1000-MW(electric) unit is approximately 800 MW if the plant is situated 50 km away from the heat load center. For further studies and realization of the plans, the cities of the HMA and the state-owned power company, the Imatra Power Company, have formed a common company for the nuclear power plant project.

35119 Duplex chemical system for the storage and container transport of heat for district heating. Taube, M. (Swiss Federal Inst. for Reactor Research, Wuerenlingen). *Nucl. Technol.;* **38**: No. 1, 62-68(Apr 1978).

A system of two-component chemical agents is proposed for transforming heat with T approximately equal to 450 +- 50 K into chemical energy, as a means of storage and transportation. The system is called SALAMO (for Salt/Ammonia), and the following boundary conditions have been arbitrarily chosen: (1) The primary source of heat is a light water reactor (LWR), with temperatures of T/sub max/ = 530 K and T/sub optim/ = 400 +- 20 K. (2) The heat energy bounded in chemical form is transported in railway wagons, in pressureless containers, at a near-ambient temperature. (3) Heat is delivered to the consumers at a temperature of 390 +- 10 K, with a power on the coldest days of at least 1 MW. This corresponds to a district having a population of several hundreds. The distance from the LWR can be as much as 100 km, although the optimum distance is 30 to 50 km. Heat can be stored for only short periods. Averaged over the whole year, the system provides 85 to 90% of the total space heating requirements, the remainder being covered by oil heating during the very coldest periods. (4) The LWRs supply the heat during their electrical off-peak periods, also during the winter. (5) Allowances are made for inherent redundancy. (6) The electrical energy for transportation over a distance of 100 km is not more than 2% of the total energy transported.

35120 Multi-stage-flash desalination plants of relative small performance with integrated pressurized water reactors as a nuclear heat source. Petersen, G.; Peltzer, M. (Gesellschaft fuer Kernergieverwertung in Schiffbau and Schiffahrt, Geestacht-Tesperhude, Ger.). *Nucl. Technol.;* **38**: No. 1, 69-74(Apr 1978).

Investigations of the requirements for seawater desalination plants with a performance in the range from 10,000 to 80,000 m^3 distillate per day heated by a nuclear reactor were conducted. The desalination plants consist of Multi-Stage-Flash (MSF) evaporators of proven design. The reactor concept is similar to the integrated pressurized water reactor (IPWR) of the nuclear ship OTTO HAHN. The design study shows that IPWR systems have specific advantages compared to other reactor types when they are adapted to single-purpose plants for water desalination or to dual-purpose plants for water desalination and electrical power generation. The calculated costs of the dual-purpose plant show the advantages of the larger unit size and the reduction in water production costs through the sale of electrical power and also gives some flexibility in the pricing of the joint products.

35121 Measures to ensure the possibility of future heat supply from the Kaiseraugst nuclear power station. Fazekas, J.; Mamuzic, M. (Kernkraftwerk Kaiseraugst AG, Baden, Ger.). *Nucl. Technol.;* **38**: No. 1, 75-82(Apr 1978).

A nuclear power station is planned to be built and operated for many years before a district heating system for the nearby city of Basel will have grown sufficiently large to be connected to the station. The design changes on the plant that will allow a retrofit for heat generation and that will not jeopardize the plant construction and operation as a purely electrical power plant until that time have been identified. Turbine extraction, layout, and piping routing are practically the only characteristics that need to be changed at the time of construction. As compared with the total plant costs, only a small additional investment is needed for these changes. Further investments will have to be made in the future when the actual heating station is added to the plant. Estimated heat generation costs justify the decision to carry out the design changes needed now to assure the feasibility of a simple future retrofit.

35122 Front heat extraction. Aussourd, P. (Electricite de France, Paris). *Nucl. Technol.;* **38**: No. 1, 97-103(Apr 1978).

Electricite de France (EdF), the French National Electric Power Company, has a large nuclear program under construction. Every possibility of providing heat from French pressurized water reactor nuclear plants has been examined. Due to the characteristics of heat needs in France, the necessity of maintaining the standardization of nuclear units as much as possible, and the possibility of tapping off steam from steam generators within 10% of the total thermal power of the reactors without modifying the constraints of operational control, EdF has decided to propose to eventual heat customers a technical solution based on tapping off heat from steam generators at the top of the steam cycle.

35123 District heating from nuclear power plants. Bogen, J.; Schueller, K.H. (Brown, Boveri and Cie AG, Mannheim, Ger.). *Nucl. Technol.;* **38**: No. 1, 104-112(Apr 1978).

Nuclear power plants are normally designed for operation with condensing turbines for pure electricity production. The rational use of primary energy demands the combined production of electricity and low-temperature heat, especially for regions with high population densities. The choice of the plant layout for combined generation of electricity and heat from nuclear power stations depends on the requirements of the electrical and district heating grids, on technological criteria of the process, as well as on economic criteria. A 3782 MJ/s pressurized water reactor (PWR) nuclear steam supply system is used as a basis for the combined production of electricity and heat produced by extracting steam from the low pressure turbines of the turbo-generator and by installing a separate heating turbine. There are no important technical changes necessary in a PWR plant, designed for electricity generation, when changing to the combined generation of electricity and heat. Since the additional equipment for district heating production is designed in detail, the additional plant costs can be estimated. The result shows that, for a heating capacity range of 349 to 1163 MJ/s, the additional plant costs are on the order of 1 to 5% of the total investment for a 1300-MW(electrical) PWR power station for pure electricity production.

35124 Steam turbines for district heating in nuclear power plants. Muehlhaeuser, H.J. (BBC Brown, Boveri and Co. Ltd., Baden, Switzerland). *Nucl. Technol.;* **38**: No. 1, 113-119(Apr 1978).

Nowadays, it is essential to save energy. By equipping the various types of power plants with district heating facilities, a major contribution can be rendered in energy conservation. Nuclear power plants can be provided with means of extracting heat for utilization in district heating schemes. All types of saturated steam cycles for district heating turbines as well as possible turbines for different heat extraction rates are discussed on the basis of a plant with an electrical output of 1000 MW.

35125 Nuclear steam turbines for power production in combination with district heating and desalination. Frilund, B.; Knudsen, K. (Turbin AB, Finspong, Sweden). *Nucl. Technol.;* **38**: No. 1, 120-125(Apr 1978).

The optimization of the turbine plant of a nuclear power station in combination with heat production is dependent upon many factors, the most important being the heat requirements, full-load equivalent operating time, and the heat transport distance, i.e., the trunk mains' costs. With hot-water-based heat transport, this usually results in a large temperature difference between supply and return water and heating in two or three stages. The turbine can consist of a back-pressure turbine, a back-pressure turbine with condensing tail, or a condensing turbine with heat extractions. The most attractive solution from technical as well as economic points of view is the condensing turbine with extraction for district heating or desalination as appropriate. The turbines can be of conventional design, with only minor modifications needed to adapt them to the operating conditions concerned.

35126 Core design and dynamics of the secure district heating reactor. Gransell, H. (AB Atomenergi, Nykoping, Sweden); Hoeglund, R. *Nucl. Technol.;* **38**: No. 1, 144-154(Apr 1978).

The SECURE (Safe and Environmentally Clean Urban REactor) concept was developed by a Finnish-Swedish project group in 1976—1977. It is a small low-pressure and low-temperature nuclear plant for district heating purposes. The special safety requirements for a reactor of this kind have led to an unconventional design with certain inherent safety features to guarantee safe shutdown without the use of any active components. The reactor is located inside a large, slightly pressurized pool containing cold water with about 1000 ppM natural boron. On shutdown, the pool water flows into the primary system to keep the reactor subcritical. Boron is also used for power control, whereas burnup is compensated for by use of the burnable absorber Gd_2O_3.

35127 Department of Energy programs to evaluate applications of heat from nuclear reactors. Savage, W.F. (Dept. of Energy, Washington, DC); Spiewak, I. *Nucl. Technol.;* **38**: No. 1, 19-24(Apr 1978).

The U.S. Department of Energy program is evaluating the applications of nuclear heat to industrial heat supply, district heating, desalting, and waste heat utilization. The approach emphasizes the study of energy generation at specific sites with well-developed technologies, including light water reactors and coal combustion. Co-generation of electric power and steam for industrial use is being evaluated both to serve individual customers and for a large thermal grid supplying many customers. Integral pressurized water conceptual designs rated at 365 and 1200 MW(thermal) have been developed to support these applications.

35128 Heat extraction from nuclear power plants. Deuster, G.; Zenker, P. (Energieversorgung Oberhausen, Ger.). *Nucl. Technol.;* **38**: No. 1, 35-40(Apr 1978).

Todays marketable light water reactor (LWR) nuclear power plants allow an appropriate design to extract heat for the purpose of district heating. Besides the desired reduction of thermal emission, the electrical output will also decrease. With helium-cooled high-temperature reactors or modified LWRs, nuclear generation of low-temperature heat can possibly be made more economical. The presence of widespread district heat networks would allow distribution of more than 1000 MJ/s from these power plants. The desired saving of primary energy, how, can be attained only by high investments.

35129 Low-temperature heat from high-temperature reactors by means of nuclear long-distance energy. Harth, R. (Kernforschungsanlage, Juelich, Ger.); Kugeler, K.; Niessen, H.F.; Boltendahl, U.; Theis, K.A. *Nucl. Technol.;* **38**: No. 2, 252-257(Apr 1978).

From Conference on low-temperature nuclear heat; Otaniemi, Finland (21 Aug 1977).

An innovative energy transport system that uses a high-temperature gas-cooled reactor (HTGR) as an energy source is suitable for any distance and is favored for long distances. Further advantages include: (1) no consumption of raw materials (apart from nuclear fuel); and (2) very low environmental impact. The purpose of the developmental work is to supply heat for district heating, process steam production, and electricity production. The basic idea of this system is: (1) to convert the heat from an HTGR by means of a gaseous endothermic chemical process into chemical energy, (2) to transport energy by the gaseous reactants at ambient temperatures, (3) to release transported energy for consumption by reversing the chemical reaction, and (4) to return the products of the reverse reaction to the energy source. Theoretical and experimental investigations concentrate on the chemical cycle of "steam reforming of methane-methanation."

35130 Dual-purpose nuclear power plants for military installations. Stewart, G.S.; Story, G.T. (USA Facilities Engineering Support Agency, Fort Belvoir, VA). *Nucl. Technol.;* **38**: No. 2, 264-270(Apr 1978).

From Conference on low-temperature nuclear heat; Otaniemi, Finland (21 Aug 1977).

Preliminary studies conducted by the Facilities Engineering Support Agency indicate that the electrical power and recoverable waste heat from a 50- to 100-MW nuclear energy center could supply the future power and space conditioning requirements of a large military installation. The plant design under study is powered by a high-temperature gas-cooled reactor (HTGR) providing electrical energy and precooler effluent of sufficiently high temperature (200°C) for use in a pressurized water district heating network. The military installation was found to be an attractive candidate for utilization of waste heat and electrical power from a central plant because of its size, diversity of energy demand, and operational character. The HTGR system was shown to have an economic advantage over a comparable system using a pressurized water reactor. It is concluded that the nuclear total energy system is technically feasible and capable of serving the utility needs of military installations in the late 1980's.

35131 Energy alternative for industry: the high-temperature gas-cooled reactor steamer. McMain, A.T. Jr. (General Atomic Co., San Diego, CA); Blok, F.J. *Nucl. Technol.;* **38**: No. 2, 271-279(Apr 1978).

From Conference on low-temperature nuclear heat; Otaniemi, Finland (21 Aug 1977).

Large industrial complexes are faced with new requirements that will lead to a transition from such fluid fuels as natural gas and oil to such solid fuels as coal and uranium for supply of industrial energy. Power plants using these latter fuels will be of moderate size [800 to 1200 MW(thermal)] and will generally have the capability of co-generating electric power and process steam. A study has been made regarding use of the 840-MW(thermal) Fort St. Vrain high-temperature gas-cooled reactor (HTGR) design for industrial applications. The initial conceptual design (referred to as the HTGR Steamer) is substantially simplified relative to Fort St. Vrain in that outlet helium and steam temperatures are lower and the reheat section is deleted from the steam generators. The Steamer has four independent steam generating loops producing a total of 277 kg/s (2.2×10^6 lb/h) of prime steam at 4.5 MPa/672 K (650 psia/750°F). The unit co-generates 46 MW(electric) and provides process steam at 8.31 MPa/762 K(1200 psia/912°F). The basic configuration and much of the equipment are retained from the Fort St. Vrain design. The system has inherent safety features important for industrial applications. These and other features indicate that the HTGR Steamer is an industrial energy option deserving additional evaluation. Subsequent work will focus on parallel design optimization and application studies.

35132 Economics of nuclear district heating from the utility's point of view. Timm, M. (Hamburgische Electrictaets-Werke, Ger.). *Nucl. Technol.;* **38**: No. 2, 280-287(Apr 1978).

From Conference on low-temperature nuclear heat; Otaniemi, Finland (21 Aug 1977).

The economy of combined nuclear power stations generating electric power and district heat is evaluated by comparing their generation costs with those of conventional fossil-fired dual-purpose stations. Realistic assumptions on several technical and economic variables and parameters (heat/power ratio, investment and fuel costs, heat transport costs) for both the nuclear and the conventional alternative were derived from the present situation and for the foreseeable future. Only light water reactor technology, with its safety standard presently approved only for remote location, was considered, therefore causing the necessity of long-distance heat transport. If only the generation costs are considered, the results show that from the economic point of view the nuclear plants are competitive with the fossil-fired stations. However, if the costs are added for the long-distance transport of nuclear heat, this economic advantage is rapidly compensated by the transport costs with increasing distance. Only very large nuclear plants--not suitable for the size of presently existing distribution systems--can economically overcome the minimum safety distance of 20 to 30 km.

35133 Estimates of the costs of steam derived from nuclear and fossil fuels. Spiewak, I.; Klepper, O.H. (Oak Ridge National Lab., TN). *Nucl. Technol.;* **38**: No. 2, 288-294(Apr 1978).

From Conference on low-temperature nuclear heat; Otaniemi, Finland (21 Aug 1977).

Process steam from intermediate size and large reactors is cheaper than steam produced in conventional boilers burning coal, or oil at $2.21/GJ($14/barrel in 1976 dollars). Small nuclear and coal-based steam supply systems may be competitive with oil under criteria that consider long-term economic inflation and the detailed financial and tax structure of the energy user.

35134 Nuclear district heating system with a high-temperature reactor. Schroeder, G. (Steag AG, Essen); Barnert, H.; Wischnewski, R. *Nucl. Technol.;* **38**: No. 2, 295-303(Apr 1978).

From Conference on low-temperature nuclear heat; Otaniemi, Finland (21 Aug 1977).

From the demand viewpoint, the connection of an installed nuclear thermal capacity of 290 MJ/s for district heating purposes would be possible in the central Ruhr District by 1982-1983. The nuclear district heating system is made up of several subsystems, for instance, a smaller size high-temperature reactor [500 MW(thermal)] as a nuclear heat-and-power plant and an interconnected district heating system with a feed temperature of 453 K (180°C). The expenditure for additional investments, additional fuel costs, and costs for substitute power capacity are charged to the thermal energy generation costs of the nuclear heat-and-power plant. For the nuclear district heating system, the district heating costs to the consumer will vary over wide limits, depending on local conditions, between 7.8 and 12.2 $/GJ at the commissioning date in 1983, assuming that all subsystems have to be newly installed. These costs can be lower than district heating costs in a conventional district heating system with fossil-fired heating stations.

35135 Cost comparison of low-temperature heat production and supply to the industrial and domestic sector by means of nuclear energy. Boese, F.K.; Breyer, W.; Pruschek, R. (Gesellschaft fuer Hochtemperaturreaktor-Technik mbH, Bergisch, Gladbach, Ger.). *Nucl. Technol.;* **38**: No. 2, 304-311(Apr 1978).

From Conference on low-temperature nuclear heat; Otaniemi, Finland (21 Aug 1977).

The economics of different nuclear systems to meet the low-temperature heat demand are compared. The comparison concentrates on substitute or synthetic natural gas (SNG) produced from coal and nuclear high-temperature heat. The market potential as well as the economic benefit for the Federal Republic of Germany (FRG) has been assessed under realistic boundary conditions. In spite of the relatively high investment costs, it is expected that SNG can be competitively used in the FRG. If a price escalation rate of natural gas slightly above the general inflation rate is assumed, a large public benefit can be expected.

35136 Effects of a pipe rupture accident on the reactor internals in a boiling water reactor demonstrated by the example of Philippsburg 1. Elter, C.; Haug, E.; Morassi, H. (Technische Ueberwachungsverein Baden, Mannheim, Ger.). *Nucl. Technol.;* **37**: No. 3, 204-226(Mar 1978).

In the course of the evaluation of the Philippsburg 1 boiling water reactor in the Federal Republic of Germany, carried out for the licensing authorities, the behavior of the reactor internals during a pipebreak accident was analyzed by theoretical calculations. During this accident, the reactor internals are exposed to a short-time negative pressure wave that expands in the water and is rapidly attenuated. The extent of the influence this load has on the operating capability of the components, particularly of the shut-down facilities, was analyzed. Linearly elastic dynamic analyses were carried out on the mechanical behavior of the structure on the basis of calculations of the time- and space-dependent pressure distribution on the core shroud and vessel dome. Staggered geometries and attenuation were not taken into consideration. All calculated components were treated as axially symmetric structures. The load is not axially symmetric and is therefore represented as a Fourier series. The results are given in the form of stresses, displacements, and forces as a function of time.

35137 Two methods of optimizing hot water pipeline networks. Barreau, A.; Moret-Bailly, J. (Angers Univ., 72 - Le Mans (France).Centre Universitaire). *Entropie;* **13**: No. 75, 21-28(May-Jun 1977). (In French).

The district heating pipe networks are very expensive; so their characteristics have to be optimized: pipe diameters, non-conductor thickness, pumping power. It is relatively easy to optimize one single pipe section but it becomes more difficult when there are many consumer's pipelines. That problem can be solved by two methods. An analytic method with Lagrange's multipliers permits the sensibility of the optimum to entering parameter variations to be studied. Another method meets Bellman's principle of the dynamic Programming: this method permits speed, pressure limits and the standard diameters to be introduced. Concretely, two Fortran computer programs are used in French CEA to estimate the downstream networks of nuclear reactors. A 20% estimated gain justifies this paper.

35138 Use of methods of optimizing hot water pipeline networks for some concrete examples. Caizergues, R.; Franenberg, H. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. des Etudes Mecaniques et Thermiques). *Entropie;* **13**: No. 75, 29-38(May-Jun 1977). (In French).

Concrete examples of application of two methods of optimising the cost of operating a heat transport and distribution network for district heating are described. The method of calculating entire parameters in the computer codes is given. A description of the programme inputs and outputs is given with an example.

NUCLEAR REACTOR TECHNOLOGY

THEORY AND CALCULATION

REFER ALSO TO CITATION(S) 35296

35139 (AECL—5179) **Application of the PRBS/FFT technique to digital simulations.** Hinds, H.W. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Jan 1977. 14p. (CONF-7506179—1). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Conference on automatic control; Vancouver, Canada (23 Jun 1975).

A method is described for obtaining a small-signal frequency response from a digital dynamic simulation. It employs a modified form of the PRBS/FFT technique, whereby a system is perturbed by a pseudo-random binary sequence and its response is analyzed

using a fast Fourier transform-based program. Two applications of the technique are described; one involves a set of two coupled, second-order, ordinary differential equations; the other is a set of non-linear partial differential equations describing the thermohydraulic behaviour of water boiling in a fuel channel.

35140 (BARC—883) **Collision probability method and its applications.** Raghav, H.P. (Bhabha Atomic Research Centre, Bombay (India)). 1977. 29p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Collision probabilities have been calculated in one energy group, for a number of systems representing geometries of interest for reactor calculations. For these calculations three programmes have been written which are CELLC, ESCAPE and TRANS. The geometries considered comprise two cases of two dimensional geometry, viz., a square cell with a circular fuel rod and a cuboid with infinite height. CELLC considers the two dimensional square lattice as such. ESCAPE and TRANS generate the required escape and transmission probabilities to be used in the recently developed response function technique for two dimensional flux distribution calculations. The result of these programmes are found to be in good agreement with Monte Carlo and other transport theory methods. The purpose of the work is to demonstrate the versatility of the collision probability method.

35141 (CEGB-RD/B/N—3414) **FRODA - a program for the analysis of frequency dynamics experiments.** Emmett, J.C.A. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). May 1976. 40p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The FRODA program has been produced for the analysis of dynamics experiments in the frequency domain. Its two main functions are the processing of experimental frequency responses and the fitting of theoretical frequency responses from various simple mathematical models to experimental plant. Two types of model can be used: (i) empirical models of which there are three different formulations of the standard polo-zero type of model and (ii) physics models which consist of a set of linearized algebraic and first order differential equations. The FRODA calculation is divided into separate tasks which may be performed singly or in any feasible combination. These tasks have all been used successfully in a simulated analysis of the P.F.R. Oscillator Experiment and it is intended to use FRODA to analyse the real experimental data when it becomes available. FRODA has been written in a general form for use for evaluation and fitting of a wide variety of simple plant models in the frequency domain. Other nuclear applications have been the analysis of noise measurements on a Magnox reactor and the setting up of a simple AGR core model for simulating a dynamic experiment to measure reactivity coefficients. A general description of FRODA and instructions on how to use the program is given.

35142 (FEI—596) **Experimental study on neutron field properties in a linear section of a sodium pipeline.** Petrov, E.E.; Trykov, L.A.; Nikolaev, A.N.; Semenov, V.P.; Sinitsyn, B.I.; Burian, I.; Yanskii, B.; Oshmera, B.; Otopal, P. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1975. 26p. (In Russian). Dep. NTIS (US Sales Only), PC A03/MF A01.

The present study continues those which have been made with a mockup of a straight section of the sodium loop of the VVR-S reactor in Rez, the CzSSR. This series of measurements pays particular attention to the study of the effect of the hollow ring slits and the ring slits filled with insulating material on the movement of neutrons through the loop. In addition, more complete data have been obtained on the energy distribution of neutrons inside the mockup and those incident on it. An estimation of the experimental errors has been made resulting from the size of the measuring channel, detector dimensions and the inleakage of neutrons through the measuring channel. The conclusions are: 1) the asymptotic neutron spectrum can be found about 150 cm away from the loop input, 2) using in insulating material (glass wool) results in the dose becoming one and a half times smaller at a distance of 200 cm away from the origin of the loop, 3) the attenuation length, lambda, is the same for resonance and fast neutrons, viz. 21 cm. For neutrons with an energy 0.4 to 1 MeV, lambda = 15-16 cm.

35143 (LA-UR—78-888) **Computational procedures for multidimensional core analysis.** Lathrop, K.D. (Los Alamos Scientific Lab., N.Mex. (USA)). 1978. Contract W-7405-ENG-36. 13p. (CONF-780401—4). Dep. NTIS, PC A02/MF A01.

From Topical meeting on advances in reactor physics; Gatlinburg, TN, USA (9 Apr 1978).

Comparisons made by the Large Core Code Evaluation Working Group (LCCEWG) show that excellent agreement is obtained by different diffusion theory codes run on different computers at different installations in computing representative models of large fast reactors. It is noted that finite difference diffusion theory computer codes are still not fast enough to run the largest problems, but the coarse-mesh nodal expansion methods now seem capable not only of providing accurate global results in very short computing times, but also of recovering consistent local flux shapes. A new multigrid method due to Brandt gives promise of very effective acceleration of diffusion equation iterations and also makes possible adaptive mesh solution procedures. The latest version of the discrete ordinates code DOT-IV allows energy and spatial variation of the discrete ordinates quadrature order as well as a form of line deletion. The three-dimensional discrete ordinates code THREETRAN (hex,.z) has been successfully used to analyze problems representative of fast reactor systems during the approach-to-critical loading phase. New discrete ordinates difference schemes are described that include a more accurate, positive weighed diamond scheme, a positive geometric mean scheme, and the analog of the diamond scheme for triangular meshes.

35144 (ORNL/NUREG/CSD/TM—2) **SUPERDAN: computer programs for calculating the Dancoff factor of spheres, cylinders, and slabs.** Knight, J.R. (Oak Ridge National Lab., Tenn. (USA)). Mar 1978. Contract W-7405-ENG-26. 62p. Dep. NTIS, PC A04/MF A01.

Resonance integral calculations for a reactor lattice require the use of the Dancoff factor. In the past, tables and approximate expressions have been used to obtain this value. In order to reduce the uncertainty in the use of approximations and to avoid the inconvenience of tables, a series of computer programs has been written to calculate the Dancoff factor. Three computer programs have been prepared, one each for infinitely long cylinders, spheres, and infinite slabs. The program for cylinders includes corrections for the effect of partial shadowing of a rod by adjacent rods and for the effect of clad surrounding the rods. The effect of clad is also considered in the slab program. Although these corrections can be applied to sphere arrays, they have not been included in the sphere program. It was felt that the infrequent use of spherical arrays did not justify the additional time and effort to include these corrections.

35145 (UJV—3941-R) **Alternating-direction implicit iterative method of solving the diffusion equation.** Zitko, J.; Suchankova, V.; Lelek, V.; Humhal, E. (Ustav Jaderneho Vyzkumu, Rez (Czechoslovakia)). Dec 1976. 26p. (In Russian). Dep. NTIS (US Sales Only), PC A03/MF A01.

The system of partial differential equations is presented for the solution of the diffusion equation. The system is defined in the Ω region with the usual boundary conditions. The objective of the computation is the determination of the dominant eigenvalue of coefficient k/sub ef/. The alternating direction implicit iterative method (ADI) was used for solving the equation. Matrix A is written as the sum $A=M+V+W$ where matrices A, V, W are tridiagonal and the eigenvalues of these matrices have non-negative real parts. The algorithm and optimal accelerating parameters were calculated and the method was verified on real problems. The results were compared with results obtained using the SOR method which proved to be eight times quicker. The iterative method may only be used for the solution of one equation by a computer with a large memory. The shortcoming of the solution of the above mentioned problem using the iterative method is the fact that matrices H, V, W do not commute.

35146 **Linear stability analysis of reactors with a delayed temperature feedback.** Dawn, T.Y.; Yang, C.M. (National Tsing-Hua Univ., Hsin-Chu, Taiwan). *Nucl. Sci. Eng.;* **65**: No. 3, 508-513(Mar 1978).

Based on the one-delay-group point reactor model, the influence of the transport time delay on the nature of the linear stability of reactor dynamics is studied with the aid of the method of D partitions. From our analysis, the stability domain can be easily determined and plotted in the parametric space. The domain of the linear stability is significantly altered by the delayed temperature feedback. Comparing the stability domain of the one-group model with the effective lifetime model and Welton's criterion, the following conclusions are obtained: (1) the straight line obtained from Welton's criterion is a tangent line of the dynamic stability boundary of the effective lifetime model; and (2) the effective lifetime model is a safe estimation of the linear stability only when the delayed neutron precursor decay constant is greater than the reciprocal time constant for heat removal.

35147 **Neutron multipilication factors as a function of temperature: a comparison of calculated and measured values for lattices using $^{233}UO_2$-ThO_2 fuel in graphite.** Newman, D.F.; Gore, B.F. (Battelle Pacific Labs., Richland, WA). *Nucl. Technol.;* **37**: No. 3, 227-245(Mar 1978).

Neutron multiplication factors calculated as a function of temperature for three graphite-moderated $^{233}UO_2$-ThO_2-fueled lattices are correlated with the values measured for these lattices in the high-temperature lattice test reactor (HTLTR). The correlation analysis is accomplished by fitting calculated values of k/sub infinity/(T) to the measured values using two least-squares-fitted correlation coefficients: (a) a normalization factor and (b) a temperature coefficient bias factor. These correlations indicate the existence of a negative (nonconservative) bias in temperature coefficients of reac-

tivity calculated using ENDF/B-IV cross-section data. Use of an alternate cross-section data set for thorium, which has a smaller resonance integral than ENDF/B-IV data, improved the agreement between calculated and measured temperature coefficients of reactivity for the three experimental lattices. The results of the correlations are used to estimate the bias in the temperature coefficient of reactivity calculated for a lattice typical of fresh ^{233}U recycle fuel for a high-temperature gas-cooled reactor (HTGR). This extrapolation to a lattice having a heavier fissile loading than the experimental lattices is accomplished using a sensitivity analysis of the estimated bias to alternate thorium cross-section data used in calculations of k/sub infinity/(T). The envelope of uncertainty expected to contain the actual values for the temperature coefficient of the reactivity for the ^{233}U-fueled HTGR lattice studied remains negative at 1600 K (1327°C). Although a broader base of experimental data with improved accuracy is always desirable, the existing data base provided by the HTLTR experiments is judged to be adequate for the verification of neutronic calculations for the HTGR containing ^{233}U fuel at its current state of development.

35148 C/sub N/ method of solving the transport equation: application to plane geometry. Kavenoky, A. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). *Nucl. Sci. Eng.;* **65**: No. 2, 209-225(Feb 1978).

The C/sub N/ method of solving the transport equation has been developed at Saclay during the past few years. This method is based on a lemma proved by Placzek; an integral equation is provided for the angular flux at the boundary of the various media, and its kernel is the infinite medium Green's function. Four plane geometry problems are solved in one-velocity theory, with a linearly anisotropic scattering kernel: the albedo for the Milne problem, the extrapolation length for the same problem, albedo and transmission factor for slabs, and the critical thickness for slab reactors. Numerical results are obtained and compared with data computed by reference methods.

35149 Spherical harmonics treatment of epithermal-neutron spectra in reactor lattices: further developments and improvements. Matausek, M.V. (Boris Kidric Inst. of Nuclear Sciences, Beograd, Yugoslavia). *Nucl. Sci. Eng.;* **65**: No. 1, 161-164(Jan 1978).

The spherical harmonics treatment of epithermal-neutron spectra in reactor lattices is examined. The condensed matrix representation is introduced for the space- and lethargy-dependent vector of the spherical harmonics flux moments. Detailed recurrence relations for the factors resulting from numerical integration of the lethargy transfer integrals, in both the fast and the resonance regions, are provided. For solving systems of interface and boundary condition equations in the space variable, a procedure based on the coefficient matrix partitioning is presented.

35150 Present art of reactivity determination. Kaneko, Y.; Nakano, M.; Matsuura, S. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). *Nippon Genshiryoku Gakkaishi;* **19**: No. 6, 380-390(Jun 1977). (In Japanese).

Experimental techniques for reactivity determination of a reactor have been one of the long standing subjects in reactor physics. Recently, such a requirement was proposed by the reactor designers and operators that the values of reactivity should be measured more accurately. This is because importance is emphasized for the role of reactivity to the performance of reactor safety, economics and operability. Motivated by the requirement, some remarkable progresses are being made for the improvement of the experimental techniques. Then, the present review summarizes the research activities on this subject, identifies several reactor physics problems to be overcome, and makes mention of the future targets.

35151 Acoustic emission in subcooled nucleate pool boiling. Nishihara, H.; Bessho, Y. (Kyoto Univ. (Japan). Faculty of Engineering). *J. Nucl. Sci. Technol. (Tokyo);* **14**: No. 6, 407-415(Jun 1977).

Intensity and power spectral density of acoustic emission in subcooled nucleate pool boiling of water from boiling inception to the heater burnout was investigated experimentally. Platinum and Ni-Cr wires with dia. 1.0 mm or smaller were used as the heater. The measurements were performed in containers at atmospheric pressure and in a dam at pressures up to 3 atm. In the former case photographic observations of boiling bubbles were also made. The acoustic emission in boiling had frequency components up to and sometimes beyond 50 kHz; the shape of power spectral densities behaved differently for heat fluxes above and below a certain value at which the overall acoustic intensity assumed a maximum value. With the increase in heat flux the acoustic emission increased in high frequencies below this heat flux, while it became eminent in low frequencies above the same heat flux. This phenomenon is related to the transition from the region with single bubbles to the region with coalesced bubbles. Resonance-like peaks found in the measurements with containers that may depend on the container geometry were not observed in the measurements in the dam and smoother power spectral densities were obtained.

35152 Study on automatic diagnosis of abnormality in nuclear reactor systems. Fukuda, T.; Shibata, H. (Tokyo Univ. (Japan)); Hara, Fumio. *Nippon Kikai Gakkai Rombunshu;* **43**: No. 366, 518-529(Feb 1977). (In Japanese).

Theoretical study was made to ensure quick detection of reactor abnormality. The main subject of this study is the quick discrimination between normal noise and abnormal signals by noticing the change of neutron flux which is related to heat generation. The dynamic behavior of neutron flux was represented by a time dependent one-dimensional one-group diffusion equation with noise terms and an equation for delayed neutrons. Observed plant signals such as coolant flow rate, pressure, and temperature were also used together with the neutron flux signal to extract a set of a few appropriate variables through factor analysis. The mathematical model of the reactor plant and the system equations for neutron flux, thermal hydraulic system, out-of-core system, and measuring system are presented in the first section. The estimation of the state of neutron flux and the logic of abnormality diagnosis are discussed in the second section. The present model for diagnosis was verified by computer simulation. The partial blockage of a core coolant channel was simulated, and the changes of coolant outlet temperature and neutron flux distribution are presented as the functions of time.

35153 Current status of fast pulsed reactor development and utilization. Suita, T. (Atomic Energy Commission, Tokyo (Japan)); Sumita, K.; Yasu, S.; Wakabayashi, H.; Wakabayashi, J. *Nippon Genshiryoku Gakkaishi;* **19**: No. 2, 73-91(Feb 1977). (In Japanese).

Current status of the utilization and development of fact pulsed reactors is reviewed with emphasis on the development program of JLB (Japan Linac Booster). The second part of this report shortly reviews the historical development of pulsed reactors and the present programs in the world. Comparison was made on the characteristics of typical single pulse reactors. Comparison of two repetitive fast pulsed reactors, IBR-2 and JLB, was also made with a table. The third part describes the present status and the future program of the pulse operation of YAYOI reactor (YAYOI-P). The fourth part is devoted to the presentation of the JLB program. The nuclear and thermal design of the reactor, the optimization of moderator design and the estimation of peak thermal neutron flux, the accelerator for beam injection, the structural design of the reactor, the analysis of dynamic characteristics, the control and the nuclear instrumentation, and the safety analysis of the reactor are the main subjects. The fifth part discusses the utilization of fast pulsed reactors. Neutron diffraction and scattering, radiation science, application to radiochemistry, activation analysis, application to medical and biological sciences, and neutron radiography are discussed by the specialists in each field. Finally, some problems associated with the development of fast pulsed reactors are shortly discussed.

35154 Comparison of three different numerical solutions for 1-d space-time kinetic benchmark problem in D_2O Reactor. Chung, D.H.; Paskievici, W. (Ec Polytech). pp 68-71 of Canadian Nuclear Association--annual international conference proceedings, 17, Volumes 1 through 6, 1977. Montreal; Canadian Nuclear Association (1977).

From 17. annual international conference of the Canadian Nuclear Association; Montreal, Ontario, Canada (5 Jun 1977).

This extended abstract presents a comparion of kinetics calculations for the one-dimensional benchmark problem as obtained using three different codes--QXI, FORSIM, AND EPKIN. The nature of the benchmark problem and the basic different characteristics of the codes are briefly described. Then the results of the three different methods are compared. Since no exact analytic solution is available in this case, the comparison does not favor any of the three codes used with respect to the accuracy. 6 refs.

35155 Heterogeneous effects on experimental integral parameters of subcritical assemblies. Yurova, L.N.; Bushuev, A.V.; Naumov, V.I.; Duvanov, V.M.; Khrennikov, N.N.; Zubarev, V.N. *At. Energ. (USSR);* **40**: No. 5, 384-386(May 1976). (In Russian).

Design and theoretical, as well as experimental, investigations of the integral parameters of carbon-uranium systems with a different number of cells have been carried out to ascertain the influence of heterogeneity and the possibility of using the theory of the material parameter when analysing results obtained for heterogeneous subcritical systems. The Galanin-Feinberg method has been used in the theoretical analysis of the heterogeneity effects. The experiments designed to study the influence of the number of cells on the parameters measured have been carried out on subcritical carbon-uranium systems with natural uranium using a reactor neutron beam. The number of cells varies from 9 to 81, the system height being 270 cm. The cadmium ratio Rsub(Cd)sup(28) and <sigmasub(f)sup(25)>/<sigmasub(f)sup(49)> has been measured. The parameter Rsub(Cd)sup(28), being the most sensitive one to changes in the dimensions of the system, remains unaffected with 25 cells or more. The results of the relative measurements of Rsub(Cd)sup(28) are in reasonable agreement with the data from the heterogeneity calculations.

COMPONENTS AND ACCESSORIES

REFER ALSO TO CITATION(S) 35124, 35297, 35552, 35562, 35594, 35601

35156 (NUREG/CR—0008) **Thermal performance measurements on ultimate heat sinks—cooling ponds.** Hadlock, R.K.; Abbey, O.B. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Dec 1977. Contract EY-76-C-06-1830. 105p. (PNL—2463). Dep. NTIS, PC A06/MF A01.

The primary objective of the studies described is to obtain the requisite data, with respect to modeling requirements, to characterize thermal performance of heat sinks for nuclear facilities existing at elevated water temperatures in result of experiencing a genuinely large heat load and responding to meteorological influence. The data should reflect thermal performance for combinations leading to worst-case meteorological influence. A geothermal water retention basin has been chosen as the site for the first measurement program and data have been obtained in the first of several experiments scheduled to be performed there. These data illustrate the thermal and water budgets during episodes of cooling from an initially high pond water bulk temperature. Monitoring proceeded while the pond experienced only meteorological and seepage influence. The data are discussed and are presented as a data volume which may be used for calculation purposes. Suggestions for future measurement programs are stated with the intent to maintain and improve relevance to nuclear ultimate heat sinks while continuing to examine the performance of the analog geothermal pond. It is further suggested that the geothermal pond, with some modification, may be a suitable site for spray pond measurements.

35157 **Assessment of failures according to aspects of fracture mechanics.** Joergens, H. pp 245-259 of Angewandte Bruchmechanik. Probleme aus der Sicht der Hersteller, Betreiber und Ueberwacher. Koeln, Germany, F.R.; TUeV Rheinland (1976). (In German)

From Symposium on applied fracture mechanics; Bad Neuenahr, F.R. Germany (15 Mar 1976).

See CONF-760385—.

Introductory remarks on failure analysis and on the basic problems of failure analysis in fracture mechanics are followed by a discussion of three concrete cases: rupture of a gate valve casing, failure of the pneumatic drive of a reactor control rod, and rupture tests on a reactor pressure vessel model.

35158 (STH—3/76) **Calibration of measuring chambers for monitoring gaseous emissions from nuclear power plants.** Kreiner, H.J.; Jagersberger, H.; Walz, K.F.; Winkelmann, I. (Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene). Oct 1976. 56p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

The calibration of 7 measuring chambers used in monitoring of gaseous effluents from nuclear power plants is described. A device for the preparation of gaseous calibration standards of different activity concentrations was tried out. The calibration measurements were carried out with Ar^{41}, Kr^{85} and Xe^{133} standards. Other measurements with Sr^{90} and Cs^{137} point sources were carried out to allow at any time a functional testing of the whole measurement equipment including the detectors. With different plastic detectors the pulse height distribution of Ar^{41}, Kr^{85}, Xe^{133}, Sr^{90} and Cs^{137} was measured. The results of those measurements are discussed with a view to choose the best discriminator level allowing the lowest detection limit.

35159 (ZJE—195) **Flaw detection in manufacture and operation of nuclear power plants.** Prepechal, J. (Skoda, Plzen (Czechoslovakia). Zavod Vystavba Jadernych Elektraren). 1977. 14p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Nondestructive materials testing methods are classified with regard to the occurrence of defects, into production tests, commissioning tests, assembly tests and operation tests. As for technology used the tests are classified into visual, surface, internal and integral tests. Depending on the defect occurrence the selection of the method is carried out with regard to shape, spatial and radiation accessibility. Tests are described employed in production and assembly whose selection is mainly affected by the safety factor. The tests are carried out using conventional and non-conventional methods, such as ultrasonic tests, radiography, magnetic or capillary technique surface tests, etc. The selection of commissioning tests primarily depends on the safety of nuclear power plant operation. Conventional and non-conventional methods are used for operation tests, the choice being mainly affected by the accessibility of test sites to personnel and by the time required for completing the tests in minimum space.

35160 **Neutron drift in heterogeneous media.** Larsen, E.W. (New York Univ., NY); Williams, M. *Nucl. Sci. Eng.;* **65**: No. 2, 290-302(Feb 1978).

It is shown that in a medium consisting of asymmetric cells, neutrons can "drift," or diffuse, in a special preferred direction. The drift is caused by selective asymmetric changes in the cross sections in each cell. Several physical mechanisms are described that produce a drift, and a possible application in a reflector design is discussed. (A reflector constructed of asymmetric cells, oriented so that the drift is always directed toward the reactor core, would be more efficient than a homogeneous driftless reflector.) The theoretical treatment consists of an asymptotic analysis of the one-dimensional neutron transport equation. A simple modification of the diffusion equation describes the neutron drift, and numerical results for several problems are provided. The solution of an initial value problem for the transport equation in an asymmetric cellular medium is compared to the corresponding diffusion theory problem. The results are in reasonably good agreement for both short and long times.

35161 **Nuclear piping seminar: experience builds to improve on-line and on-the-way plants.** *Power (N.Y.);* **121**: No. 12, 70-72(Dec 1977).

A report is given on a two-day Nuclear Piping Seminar in Chicago, organized by the Power magazine. It allowed key nuclear-plant engineers and several men from nuclear architect/engineer firms to exchange opinions and offer suggestions on improvement of nuclear piping. Shortcomings in the feedback from plant construction and operation and intereferences are stressed. High value of modeling (the best scale being 1/2 or 3/4 in. to the foot) is pointed out. Experience of maintenance is summed up.

35162 **Use divers to solve underwater problems.** Leech, S.; Eliasz, R.W.; Jennings, C. (Underwater Constr Corp). *Power (N.Y.);* **121**: No. 12, 56-61(Dec 1977).

Nuclear energy has broadened the applications of underwater techniques to maintenance of central power stations. Experience has proved underwater repairs to be time-saving, cost-effective, and generally achievable without interrupting plant operations. The purpose of the article is to cast more light on the opportunities available at these utilities for maintenance by trained divers, as well as on the difficulties that limit their effectiveness.

35163 **Inductive bending machine seeks to reduce number of welds in nuclear piping systems.** O'Keefe, W. *Power (N.Y.);* **121**: No. 12, 74-75(Dec 1977).

A large pipe-bending machine, Cojafex, licensed from the Soviet bloc through a Dutch firm and now working at the Tulsa Tube Bending Co, Tulsa, Okla., is described. The machine makes bends of 1 to 180 deg, with a bend radius of about 12 to 79 in. Pipe sizes range from 7.88 to 28 in. OD, with wall thicknesses to 4 in. Larger machines in Europe can bend 64-in. pipe with a 4-in. wall. Two parallel rails support the sideways-moving frame, and a curved rail supports the end of the arm, which is pivoted on a large bearing mounted near the frame head. When the frame and clamp on the arm are set at the desired bend radius from the arm pivot, the straight pipe is lowered into the frame well and into the clamp, with an induction-heating ring and quenching-water ring around the pipe. Up to 475 kVA power on the ring heats a narrow zone, and the pusher block behind the pipe provides bending energy. The pusher block is drawn forward by a double-chain drive. Swing of the arm about its pivot directs the bend; controlled guide heads at the pipe sides near the heated zone are also important in achieving results.

35164 **Coatings for nuclear power plants.** Berger, D.M. (Gilbert/Comonwealth Cos). *Power Eng.;* **81**: No. 11, 93-96(Nov 1977).

Nuclear grade coatings must be able to simultaneously withstand exposure to high humidity and radiation dosage for the design life of a plant. In addition, coatings must be of sufficient durability to withstand projected conditions of the design basis accident. Meeting these challenges is a new coatings technology which is supported by an elaborate means of testing and evaluation. The tests involved are described in several documents and references. Although several tests have been included in these documents, the most significant are: (1) design basis accident; (2) irradiation; and (3) decontamination factor. A coating system must pass all three of these tests to be accepted. Oak Ridge National Laboratory has established the acceptable criteria for each test.

35165 **Limit design of perforated cylindrical shells per ADME code.** Porowski, J.S.; O'Donnell, W.J.; Farr, J.R. (Prosynchem, Gliwice, Pol). *J. Pressure Vessel Technol.;* **99**: No. 4, 646-650(Nov 1977).

Limit pressures are evaluated for cylindrical perforated shells containing circular holes arranged in the various penetration patterns typically found in practice. Statically admissible discontinuous fields of stress are used to obtain rigorous lower-bound limit pressures. These solutions are shown to be quite close to the actual limit pressures based on the efficiency of the discontinuous fields of stress and a comparison with upper-bound solutions. The optimal spacing parameters are obtained over the interesting range of ligament efficiencies for both the diamond (rhomboidal) and rectangular penetration patterns. The results of this work show that for most

penetration configurations, the present ASME standards require substantially thicker shells than would be needed to maintain the same safety factors that are used for unperforated shells. 6 refs.

35166 Residual ductility and residual stresses in formed heads. Gerdeen, J.C. (Mich Technol Univ, Houghton). *J. Pressure Vessel Technol.;* **99**: No. 4, 593-599(Nov 1977).

35167 Ultrasonics--closer to defect evaluation. Huebner, W. (Babcock-Brown Bovari Reak, Mannheim, Ger). *Weld. Des. Fabr.;* **50**: No. 10, 95-97(Oct 1977).

Manufacturers of reactor components use ultrasonic testing to check the integrity of base metal and of ferritic and austenitic weld metal cladding. Knowing how the u.t. signal corresponds to defect size provides a basis for identifying defects solely by their u.t. reflection patterns. Investigators used this method for measuring slag inclusions, the type of defect most commonly found in submerged arc cladding.

35168 Improvements in or relating to vessels. Williams, D.T.; Clarke, M.A. (to Taylor Woodrow Construction Ltd., Southall (UK)). British Patent 1,486,239/A/. 21 Sep 1977. 4p.

A reactor containment vessel is described that is suitable for a boiling water reactor, a high temperature reactor, or a liquid metal or gas cooled fast breeder reactor. Such vessels are required to contain fluids under high pressure, say in the range of 400 to 12,000 lb/sq.in. Full constructional details are given.

35169 Nuclear facilities; surface cleanliness of components. Measures on the building site. Draft. Berlin, Germany, F.R.; Beuth (Sep 1977). 4p. (In German).

This standard gives guidelines for the establishment of cleanliness areas on building sites in order to keep components and systems clean. Quality assurance measures are mentioned in order to ensure that there will be no contamination or damage until the facility is taken into operation.

35170 Higher operational safety of tube bundle heat exchangers due to modern production methods. Fahrmer, J.; Epperlein, H. *Tech. Ueberwach.;* **18**: No. 9, 289-292(Sep 1977). (In German).

If one looks only at the typical forms of multitubular heat exchangers one finds that there has been a certain standstill in the last few years with regard to construction and improvements. The total efficiency can hardly be improved, but the efficiency relative to the heating costs can. The susceptibility to damage can be reduced, i.e. operational reliability and service life increased. The main topic of the paper, however is quality improvement measures during production. Among these are greater exactness in the production of tube plates, support plates, baffle plates etc. The article shows that this is possible without additional cost and with a positive effect on the technology of welding and fastening the tubes between the tube plates.

35171 Further development of the spindle seal on reactor valves and developments for increasing serviceability--initial results of the bmft development project. Zilling, H. (Klein, Schanzlin and Becker Werk Amag, Nuremberg, Ger). *VGB Kraftwerkstech.;* **57**: No. 9, 591-598(Sep 1977). (In German).

In connection with a research project on spindle seal packing glands and siphons, a literature search which proved to be only marginally profitable, was made regarding packing glands for sealing oscillating rods. In order to design single-wall siphons, a program was developed in which by applying boundary conditions such as range, pressure, and setting--the distortion tension which occurs in each section of the siphon and also its life can be calculated. In connection with a separate project regarding the serviceability of reactor valves the results of time studies carried out during the installation of dampers and valves are evaluated. 2 refs.

35172 Mannlochverschluesse fuer Dampferzeuger-Druckkoerper, Ausfuehrung. Entwurf. (Manhole blanking devices for pressure containing steam generator parts, design. Draft). Berlin, Germany, F.R.; Beuth (Aug 1977). 2p. (In German). (DIN—2914).

Shape, design, fixing, and measurements of openings and lids are described for inner rooms which have to be accessible for assembly, maintenance, inspection and the like.

35173 Testing intermediate separators/superheater for a k-200-44/3000 turbine at the Kola nuclear power plant. Volkov, A.P.; Kelin, G.E.; Randin, V.N.; Demidova, L.N.; Paskar', B.L.; Povarov, O.A.; Sorokin, Yu.L.; Fedorovich, E.D. (Cent Sci Res Boiler and Turbine Inst, USSR). *Teploenergetika (Moscow);* No. 7, 28-31(Jul 1977). (In Russian).

Intermediate separators/superheaters (ISS) belong to new power equipment which has come into being in connection with the use of saturated steam at nuclear power plants. Steam separation and its superheating after the high-pressure cylinder improve the efficiency and reliability of turbine plants. The basic thermal diagram of connection of the ISS is presented and the tests carried out on it are described. It is found that the separation devices operate satisfactorily ensuring moisture content not exceeding 0.5%, with the mean value being 0.25%. The superheating part is highly efficient.

35174 Isolation of the pipes protruding from the reactor containment in the case of a release of radioactive substances within the reactor containment. Koeln, Germany, F.R.; Heymanns (Jun 1977). 23p. (In German). (KTA—3404).

The rule draft applies to the isolation of pipes protruding from the reactor containment of stationary nuclear power plants with LWRs. Requirements to be made on design, turn-on closure time, impermeability, and inspections are stipulated, in order to warrant the isolation of pipes protruding from the reactor containment in the case of radioactive substances beeing released into the inner atmosphere of a reactor containment - in particular on account of LOCAs or, dependent on the design basis, as a result of can failures.

35175 Probe support for automatic probe guidance along three-dimensionally curved surfaces, in particular of reactor pressure vessels. Schlueter, H. (to Maschinenfabrik Augsburg-Nuernberg (M.A.N.) A.G., Nuernberg (Germany, F.R.)). German(FRG) Patent 2,537,613/A/. 10 Mar 1977. 11p. (In German).

The invention concerns improvements for a well-tried device for an automatic guidance of ultrasonic probes along three-dimensionally curved surfaces. A major improvement is the possibility to connect several ultrasonic probes, with only a small distance between them, to form a test series.

35176 Piping information centralized management system for nuclear plant, PIMAS. Matsumoto, M. (Mitsubishi Heavy Industries Ltd., Kobe (Japan). Kobe Shipbuilding and Engine Works). *Haikan Gijutsu;* **19**: No. 4, 70-78(Mar 1977). (In Japanese).

Piping works frequently cause many troubles in the progress of construction works, because piping is the final procedure in design and construction and is forced to suffer the problems in earlier stages. The enormous amount of data on quality control and management leads to the employment of many unskilled designers of low technical ability, and it causes confusion in installation and inspection works. In order to improve the situation, the "piping information management system for nuclear plants (PIMAS)" has been introduced attempting labor-saving and speed-up. Its main purposes are the mechanization of drafting works, the centralization of piping informations, labor-saving and speed-up in preparing production control data and material management. The features of the system are as follows: anyone can use the same informations whenever he requires them because the informations handled in design works are contained in a large computer; the system can be operated on-line, and the terminals are provided in the sections which require informations; and the sub-systems are completed for preparing a variety of drawings and data. Through the system, material control has become possible by using the material data in each plant, stock material data and the information on the revision of drawings in the design department. Efficiency improvement and information centralization in the manufacturing department have also been achieved because the computer has prepared many kinds of slips based on unified drawings and accurate informations.

35177 Nuclear science and metallurgy. progress and interactions. Grison, E. (Cent d'Etud Nucl de Saclay, Fr). *Rev. Metall. (Paris);* **74**: No. 8/9, 425-435(1977). (In French).

This paper includes a brief summary of uranium metallurgy and of the "new" metals, especially zirconium. It discusses the role of structural steel for nuclear purposes in general and its use in reactor vessels in particular. It also deals with corrosion by water and radiation effects.

35178 Calculation and design of hydrostatic seals of pump rotors for nuclear power plants. Lisitsyn, K.V.; Martsinkovskii, V.A. (Khar'kov Polytech Inst, Sumy, Ukr SSR). *Energomashinostroenie;* No. 8, 17-20(1977). (In Russian).

A description and static calculation of a new type of throttleless hydrostatic seal are given. The design and results of tests of the sealing systems of the cooling down pump and of the main circulation pump are presented.

35179 Present status of the techniques of neutron flux density measurement. Bucher, W.; Taubmann, W. (Hartmann and Braun Mess- und Regeltech, Munich, Ger). *Kerntechnik;* **19**: No. 9/10, 409-417(1977).

Neutron flux density is a very important quantity for reactor control. The necessity of an extremely wide measuring range and different physical conditions in several types of reactors led to the introduction of various principles of measurement. These have been refined permanently the last years. 5 refs.

35180 Eulerian method for large-displacement fluid-structure interaction in reactor containments. Chang, Y.W.; Wang, C.Y. (Argonne Natl Lab, Ill). pp 1-14 of Canadian Nuclear Association--

annual international conference proceedings, 17, Volumes 1 through 6, 1977. Montreal; Canadian Nuclear Association (1977).

From 17. annual international conference of the Canadian Nuclear Association; Montreal, Ontario, Canada (5 Jun 1977).

An Eulerian method for analyzing large-displacement fluid-structure interaction in reactor containments is presented. The emphasis is on the development of a generalized hydrodynamic scheme to treat the irregular cells created by the movement of the structure with respect to the fixed Eulerian coordinates. A relaxation equation is derived from the boundary condition at the fluid-structure interface for the solution of the pressure at the interface. By combining this with the Poisson equation a sufficient set of equations is obtained for the determination of the advanced-time pressures in the fluid region and at the fluid-structure interfaces. Sample problems are given to illustrate the analysis.

35181 Optimization of time and location dependent spent nuclear fuel storage capacity. Macek, V. Blacksburg, VA; Virginia Polytechnic Inst. and State Univ. (1977). 284p. University Microfilms Order No. 78-01,595.

Thesis (Ph. D.).

A linear spent fuel storage model is developed to identify cost-effective spent nuclear fuel storage strategies. The purpose of this model is to provide guidelines for the implementation of the optimal time-dependent spent fuel storage capacity expansion in view of the current economic and regulatory environment which has resulted in phase-out of the closed nuclear fuel cycle. Management alternatives of the spent fuel storage backlog, which is created by mismatch between spent fuel generation rate and spent fuel disposition capability, are represented by aggregate decision variables which describe the time dependent on-reactor-site and off-site spent fuel storage capacity additions, and the amount of spent fuel transferred to off-site storage facilities. Principal constraints of the model assure determination of cost optimal spent fuel storage expansion strategies, while spent fuel storage requirements are met at all times. A detailed physical and economic analysis of the essential components of the spent fuel storage problem, which precedes the model development, assures its realism. The effects of technological limitations on the on-site spent fuel storage expansion and timing of reinitiation of the spent fuel reprocessing on optimal spent fuel storage capacity expansion are investigated. The principal results of the study indicate that (a) expansion of storage capacity beyond that of currently planned facilities is necessary, and (b) economics of the post-reactor fuel cycle is extremely sensitive to the timing of reinitiation of spent fuel reprocessing. Postponement of reprocessing beyond mid-1982 may result in net negative economic liability of the back end of the nuclear fuel cycle.

35182 Method of operating a nuclear power plant with closed working-gas circuit and nuclear power plant for applying the method. Foerster, S.; Dibelius, G.; Hewing, G.; Singh, J. (to Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.)). German(FRG) Patent 2,526,147/A/. 23 Dec 1976. 47p. (In German).

In order to improve the method of operating a nuclear power plant with closed working-gas circuit, designed in multi-looop construction, two variants of conducting the gas circuit, which is divided into three separate partial gas flows, are proposed. In one, the working gas is brought together before compression and then compressed in three steps with intermediate cooling, in the other variant the gas streams are joined stepwise before each compression stage; the total flow is cooled prior to the last compresssion stage. The method allows optimum utilization of the space enclosed. The details of design advantage in applying the method are explicitly explained.

35183 Use of particle track detectors in the investigation of static reactor parameters. Jozefowicz, K. (Institute of Nuclear Research, Warsaw (Poland)). *Nukleonika;* **19**: No. 6, 557-563(1974). (In Russian).

The technique of particle track detectors, especially fission track detectors is described. Examples of application of these detectors for the determination of reaction rate distribution and fission rate ratio of fissionable isotopes are given.

FUEL ELEMENTS

REFER ALSO TO CITATION(S) 35245, 35246

35184 (BARC—891) **Determination of nuclear fuel burnup using mass spectrometric techniques.** Saha, B.; Bagyalakshmi, R.; Periaswami, G.; Kavimandan, V.D.; Chitambar, S.A.; Jain, H.C.; Mathews, C.K. (Bhabha Atomic Research Centre, Bombay (India)). 1977. 21p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Determination of burnup using a stable fission product monitor such as ^{148}Nd and heavy elements, determined by isotope dilution mass spectrometry gives the most accurate data. This report describes the work carried out to standardise the conditions for burnup determination. Some typical results are given.

35185 (JAERI-M—6839) **Conception, definition, measuring procedure of grain size. A grain size diameter determination of a UO_2 pellet.** Yanagisawa, K. (Japan Atomic Energy Research Inst., Tokyo). Dec 1976. 58p. (In Japanese). Dep. NTIS (US Sales Only), PC A04/MF A01.

The conception, definition, measuring procedure of "Grain Size" were surveyed. A concept "grain diameter" was introduced after deriving a calculation formula for the grain diameter for using the Comparison (simple) and Intercept(detailed) procedure. As an example and putting into practice, the grain diameter determination was carried out by means of the Comparison procedure for a UO_2 pellet used in a densification experiment.

35186 (Juel—1428) **γ-spectrometric burn-up measurements on spherical fuel elements.** Duwe, R.; Kuehnlein, W.; Schroeder, R. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorwerkstoffe und Heisse Zellen). Jun 1977. 36p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

In the hot cell laboratories at KFA Juelich the burnup of spherical fuel elements is determined by measuring the Cs^{137} activity produced during irradiation by means of gamma-spectroscopy. A large number of these spheres is taken from the AVR regularly and in order to reduce hot-cell-time for each sphere. The fuel element is placed in the hot cell in defined position. The measuring equipment consisting of a Ge(Li) detector and the pulse electronics equipment with multichannel-analyser is mounted in the inactive service area. A specially designed collimator is positioned in a penetration in the cell wall to reduce the intensity of the gamma beam. Up to now more than 1800 spheres have been measured. By comparing the results with mass-spectrometric measurements a difference of less than +- 5% was found.

35187 Digital transfer matrix for fuel pin heat transfer. Green, M.D.; Kornfilt, J. (Bogazici Univ., Istanbul). *Nucl. Sci. Eng.;* **65**: No. 2, 385-393(Feb 1978).

A method for rapid numerical simulation of transient radial heat transfer in nuclear fuel pins is presented. The method is based on a z-transfer matrix formulation of the transient conduction equations and assumes constant physical properties. The elements of the z-transfer matrix are obtained from Laplace transfer functions that are polynomial approximations to the exact equations over a specifiable frequency band, weighted to a better fit in the least-squares sense for frequencies for which inputs are expected to have higher amplitudes than for frequencies for which amplitudes of inputs are expected to be lower. Examples that demonstrate the method suitable for a large number of the transients encountered in plant dynamic analysis are presented.

35188 Calculation of dryout in a rod bundle. Whalley, P.B. (AERE, Harwell, Oxfs, Engl). *Int. J. Multiphase Flow;* **3**: No. 6, 501-515(Dec 1977).

A model of annular two-phase flow is used to calculate dryout on the assumption that dryout occurs when the liquid flowrate in the film on the solid surfaces becomes equal to zero. To enable the calculation to be performed, the processes of entrainment and deposition of liquid droplets must be adequately described. The rod bundle is divided, for calculational purposes, into rod centered subchannels, and the liquid flows in the liquid films and as droplets in each subchannel are calculated. 37 refs.

35189 Nuclear fuel rod. Steven, J. (to Kraftwerk Union A.G., Muelheim an der Ruhr (Germany, F.R.)). German(FRG) Patent 2,543,462/A/. 31 Mar 1977. 7p. (In German).

A fuel rod is described which consists of a gas-tight cladding tube filled with nuclear fuel, on one end of which there is a zone filled with a gas-adsorbing material which takes up fission gases. The adsorption material is activated carbon which is contained in a capsule provided with a gas-permeable screen on the side facing the nuclear fuel.

35190 Pellet cladding interaction for water reactors: Experience, testing and evaluation. Summary report on the specialist meeting held in Vienna from 27 June to 1 July 1977. Locke, D.H. (UKAEA, Nuclear Power Development Lab., Springfields, Preston, Lancs, United Kingdom). *At. Energy Rev.;* **15**: No. 4, 779-792(1977).

The report considers the effects of fuel pellet-cladding interactions discussed during the specialists' meeting. The main effects were those giving rise to geometrical changes in the fuel and cladding and to stress corrosion cracking of zircaloy cladding. Most of the reported experience was made with UO_2 fuel pellets contained in a zircaloy can. Variants such as vibrocompacted fuel and mixed PuO_2-UO_2 fuel, both contained in zircaloy cladding, were also considered. Reactor experience covered CANDU reactors, PWRs, BWRs, SGHWR and various loop experiments particularly in DIDO MTR, Halden BHWR, Studsvik R2, Petten, Cadarache and Chalk River. Simulation of the factors causing stress corrosion

cracking in power reactors made it possible to postulate the most probable mechanisms. Attention was also paid to the development of deterministic fuel performance codes designed to model the fuel-cladding interaction process.

35191 Some results of post-reactor investigations of the six-element thermionic assembly after 2670 hours of operation. Batyrbekov, G.A.; Bekmukhambegov, E.S.; Berzhatii, V.I. (and others). *At. Energ. (USSR);* **40**: No. 5, 382-384(May 1976). (In Russian).

Results of postreactor investigations of a six-element thermoemission assembly, operating for 2,670 hrs, confirm that the main reasons responsible for power drop during trials are lamination of collector packages and short circuiting of elements due to swelling processes. An increase by 0.3-0.6 mm is observed in the emitter diameters of all the elements. Increase in emitter diameter has been found to correlate with heat-evolution and emitter temperature distribution. Measurements have shown the existence of a substantial nonuniformity in heat-evolution over the assembly height: the rod-volume relative mean density of volumetric heat-evolution in the central and middle elements being more than that in the peripheral elements by 1.37 and 1.28 times, respectively. Nonuniform heat-evolution is also observed over the height of individual elements, especially the extreme ones. In order to increase the life of similar assemblies, it is essential to develop a collector package with stable thermophysical properties and to organize continuous evacuation of gaseous fission products from the emitter unit.

35192 Some reactivity and power transients in FBTR. Kumar, S.S.; Ravi Prasan, G.R.; Chaba, A.P. (Reactor Research Centre, Kalpakkam (India). Fast Breeder Test Reactor Design Group). pp 133-143 of Proceedings of the symposium on power plant dynamics and control. Bombay; Department of Atomic Energy (1976).

From Symposium on power plant dynamics and control; Bombay, India (23 Feb 1976).

See CONF-760265—.

The external feedback for FBTR plant has a transport lag of about 50 seconds. This permits the study of some incidents by considering the reactor only, detached from the rest of the plant, with a precise computational model. The results for certain reactivity transients due to power-coolant mismatch are listed. The computations have been done with the use of Continuous System Modelling Program (CSMP) package available on IBM 370 computer system.

CONTROL SYSTEMS

35193 (AAEC-LIB/Trans—631) **Design measures to increase safety and reliability of power station control and protection systems.** Edelmann, J.; Spieth, W. Jun 1977. Translated from AEC-CONF-75-627-001. 24p.p. Dep. NTIS (US Sales Only), PC A02/MF A01.

A few criteria which exert a considerable influence on the safety and reliability of monitoring and control systems are reviewed. When judging the safety and reliability of a system, it is of importance not only to look at the failures of just one part of a system but also to take into account the effect these failures have on the overall process. In this respect there is a marked difference between a centralized and a decentralized system. With the technical equipment nowadays at our disposal a high safety standard has been reached. Redundant and dynamic protection systems make the occurrence of a dangerous failure hypothetic.

35194 Control system for a nuclear power plant. Durrant, O.W. (to Babcock and Wilcox Co., New York (USA)). German(FRG) Patent 2,620,887/A/. 31 Mar 1977. 23p. (In German).

The invention has the target of improving the control of a nuclear power plant with regard to a better response threshold. This is achieved by combining the following elements: a) A device generating a control signal proportional to the desired power of the nuclear power plant, b) a second device controlling the heat emission of the reactor, c) a third device controlling the feedwater supply to the steam generator; the second and third device respond only to the above mentioned control signal and are to be operated in parallel to it, provided that, d) reactor heat emission and feedwater supply to the steam generator are always kept in a certain functional relation to the control signal.

35195 Computers in nuclear power plant control : a critical review. Bairi, B.R.; Subramaniam, K.; Ray, R.N.; Umesh Chandra (Bhabha Atomic Research Centre, Bombay (India). Reactor Control Div.). pp 399-412 of Proceedings of the symposium on power plant dynamics and control. Bombay; Department of Atomic Energy (1976).

From Symposium on power plant dynamics and control; Bombay, India (23 Feb 1976).

See CONF-760265—.

Computers have been extensively used in power plants for monitoring, display and supervision of plant operations. Direct digital control by computers has replaced conventional analog methods resulting in improved efficiency of operation. The rationale behind the introduction of computers in nuclear power plants is discussed. An attempt is made to highlight the advantages, difficulties, experiences and developments underlying the application of computers to plant control. Reliability considerations and principal areas of application of computer systems are briefly reviewed.

35196 Dynamics of a boiling water reactor. Girijashankar, P.V.; Srikantiah, G. (Indian Inst. of Tech., Kanpur. Dept. of Mechanical Engineering and Nuclear Centre); Pai, M.A. (Indian Inst. of Tech., Kanpur. Dept. of Electrical Engineering). pp 83-104 of Proceedings of the symposium on power plant dynamics and control. Bombay; Department of Atomic Energy (1976).

From Symposium on power plant dynamics and control; Bombay, India (23 Feb 1976).

See CONF-760265—.

A non-linear model of a boiling water reactor (BWR) has been presented. Two operating points are chosen and the mathematical model is linearized around these operating points. Both the time and frequency response studies are made on the model and these are compared against actual test results. The results of simulation indicate a good degree of confidence in the linearized model. The application of optimal control theory to devise suitable control laws for the BWR in the presence of disturbances is indicated.

35197 Modification to 200 MW(e) CANDU for improved dynamic behavior. Chamany, B.F.; Murthy, L.G.K.; Ray, R.N. (Bhabha Atomic Research Centre, Bombay (India)). pp 70-80 of Proceedings of the symposium on power plant dynamics, and control. Bombay; Department of Atomic Energy (1976).

From Symposium on power plant dynamics and control; Bombay, India (23 Feb 1976).

See CONF-760265—.

Rajasthan Atomic Power Station is inherently suitable for base load operation. Its control philosophy is based on turbine following the reactor. However, due to load fluctuations and inherent limitation of the control system, there had been considerable number of outages of the station. This limitation is further enhanced by improper choice of the operating pressure range of the boilers. Besides, existing fuel design does not permit thermal cycling and hence there is no use in attempting to make the reactor follow the turbine. Design modifications have been suggested for incorporation in the further 200 MW(e) systems. The method adopted is complete decoupling of the reactor from the load. Dynamic behaviour of the station with the suggested modifications and its comparison with the existing situation has been brought out.

35198 Control tuning to improve plant availability. Jagannathan, P.; Subramaniam, M.G.; Singhal, S. (B.H.E.L. Consultancy Services, New Delhi (India)). pp 55-69 of Proceedings of the symposium on power plant dynamics and control. Bombay; Department of Atomic Energy (1976).

From Symposium on power plant dynamics and control; Bombay, India (23 Feb 1976).

See CONF-760265—.

Rajasthan Atomic Power Plant (RAPP) is a 200 MW nuclear power plant in a relatively small sized Rajasthan State Electricity Board (RSEB) grid. The basic control scheme is modelled after Douglas point, and hence essentially designed for base load operation. Tuning of the controllers or redesign of some of the controls may be needed to adapt RAPP to RSEB grid. Tuning of some of the major controllers such as boiler pressure control, primary heat transport, system pressure control etc. is suggested to improve the availability of the plant. The plant response for typical external (from the grid) and internal (from the reactor) disturbances has been presented to highlight the effect of such tuning.

35199 Dynamics of RAPS: some operational experiences. Ojha, K.P.; Surendar, Ch. (Rajasthan Atomic Power Project, Kota (India)). pp 21-34 of Proceedings of the symposium on power plant dynamics and control. Bombay; Department of Atomic Energy (1976).

From Symposium on power plant dynamics and control; Bombay, India (23 Feb 1976).

See CONF-760265—.

Operational experiences at RAPS during several transients such as load throw-off and load assumptions are considered. Changes such as reduction of reactor set-back rate, tuning of boiler pressure controllers etc. are discussed. Effects due to voltage and frequency transients are presented. Some aspects which need further study and changes which could load to improved capability of surviving transients are indicated.

35200 Dynamic behavior of CANDU reactor. Subramanian, M.G. (B.H.E.L. Consultancy Services, New Delhi (India)); Srikantiah, G. (Indian Inst. of Tech., Kanpur. Dept. of Mechanical Engineering and Nuclear Centre); Pai, M.A. (Indian Inst. of Tech., Kanpur. Dept. of Electrical Engineering). pp 47-54 of Proceedings

of the symposium on power plant dynamics and control. Bombay; Department of Atomic Energy (1976).

From Symposium on power plant dynamics and control; Bombay, India (23 Feb 1976).

See CONF-760265—.

Understanding of the dynamic behavior of a reactor system in a power station is essential for evolving control strategies as well as design modifications. The dynamic behavior of Rajasthan Atomic Power Station is studied. Mathematical models for the reactor, the steam generator and the steam drum with the natural circulation loop are developed from physical principles like conservation of mass, momentum and energy. Each of these models is then simulated on a digital computer to obtain the characteristics during transients. The models are then combined to yield a dynamic mathematical model of the system comprising the reactor, the steam generator and the steam drum and this results in a nonlinear model. Using this model, responses of the system for various disturbances like step change in the area of the steam valve, step change in the temperature of feed water are obtained and are discussed.

ENVIRONMENTAL ASPECTS

REFER ALSO TO CITATION(S) 35999

35201 (NUREG—0404(Vol.1)(Draft)) **Generic environmental impact statement on handling and storage of spent light water power reactor fuel. Executive summary and text.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Nuclear Material Safety and Safeguards). Mar 1978. 142p. Regulatory Commission, Washington, DC.

The study covers the following: (1) The magnitude of the possible shortage of spent fuel storage capacity; (2) The options for dealing with the problem; (3) A cost-benefit analysis of the alternatives; (4) The impacts of possible additional transportation of spent fuel that may be required should one or more of the options be adopted; (5) The need for more definitive regulations and guidance covering the licensing of one or more of the options for dealing with the problem; and (6) The possible need for amendments to 10 CFR 51.20(e). The scope of this study is limited to considerations pertinent to the interim storage of spent fuel.

35202 (NUREG—0404(Vol.2)(App.)(Draft)) **Generic environmental impact statement on handling and storage of spent light water power reactor fuel. Appendices.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Nuclear Material Safety and Safeguards). Mar 1978. 253p. Regulatory Commission, Washington, DC.

Detailed appendices are included with the following titles: light water reactor fuel cycle, present practice, model 1000MW(e) coal-fired power plant, increasing fuel storage capacity, spent fuel transshipment, spent fuel generation and storage data (1976-2000), characteristics of nuclear fuel, and "away-from-reactor" storage concept.

35203 (ORAU/IEA(O)—77-31) **Toward an acceptable nuclear future.** Weinberg, A.M. (Institute for Energy Analysis, Oak Ridge, Tenn. (USA)). Nov 1977. Contract EY-76-C-05-0033. 25p. Dep. NTIS, PC A02/MF A01.

The nuclear option is in danger of being foreclosed. The trend toward antinuclearism may be reversed if concerns about low-level radiation insult can be shown ultimately to be without foundation; evidence for this speculation is presented. Nevertheless it is suggested that the nuclear enterprise itself must propose new initiatives to increase the acceptability of nuclear energy. A key element of an acceptable nuclear future is cluster siting of reactors. This siting plan might be achieved by confining new reactors essentially to existing sites.

35204 **Public attitudes to nuclear energy.** Lenihan, J. (Western Regional Hospital Board, Glasgow (UK). Dept. of Clinical Physics and Bio-Engineering). *Atom (London);* No. 253, 319-323(Nov 1977).

From 5. Public Relations symposium of the International Union of Producers and Distributors of Eletrical Energy; Edinburgh, UK (6 Sep 1977).

Technology is now being blamed for many of the world's misfortunes. The reasons for this attitude are not obvious, but several possible explanations are advanced. Nuclear power and the fears it arouses are discussed and comparisons made with other industries.

35205 **Dangers of escalating uncertainty.** Rose, D.J. (Massachusetts Inst. of Tech., Cambridge (USA)). *Nucl. Eng. Int.;* **22**: No. 264, 66-67(Nov 1977).

From an independent standpoint, an assessment is made of the impact of uncertainty on the investment decisions of utilities and vendors, and its exploitation by critics. It is argued that the problems raised in the nuclear debate and by proliferation are social not technical and therefore need social solutions.

35206 **Nuclear power: pros and cons. The nuclear power information campaign of the Austrian federal government - analyses and conclusions.** Hirsch, H. (Bundesministerium fuer Handel, Gewerbe und Industrie, Vienna (Austria). Sektion 5). *Phys. Bl.;* **33**: No. 9, 385-395(Sep 1977). (In German).

The author deals with the nuclear power controversy in science and indicates the main points of the nuclear power debate by the population. The different scientific and ideological positions shown by the results of the campaign are explained.

35207 **Why nuclear debate in Canada has intensified: and why it will continue.** Phillipson, D.J.C. *Sci. Forum;* **10**: No. 4, 3-7(Aug 1977).

Some activities of members of the Canadian antinuclear movement (notably Energy Probe and the Canadian Coalition for Nuclear Responsibility) are discussed. Some topics of controversy discussed include positive versus negative void coefficients, shutdown systems, and allegations that documents dealing with safety were secret. Both Pickering and Bruce have cadmium rods for the primary shutdown system, but Pickering has moderator dump for the secondary system, whereas Bruce has poison injection into the moderator. A brief description is included. The AECB could codify and publish some of its rules for licensing, but it must consider each case on its merits. The opponents seek an absolute theoretical safety which would exceed all practicality.

35208 **Things nuclear: the Canadian debate.** Mueller, P.G. Toronto, Ont.; Canadian Institute of International Affairs (1977). 39p.

An unbiased overview is given of the nuclear industry in Canada, with emphasis on its history, fundamentals of nuclear power plants and the CANDU reactor system, the need and ideal mix of future energy sources, economics of nuclear power, uranium supplies, radioactive releases, thermal pollution, physical security, and safety of nuclear power plants, and export of CANDU technology vs. nuclear proliferation.

35209 **Environmental protection programs and results in Ontario Hydro's Nuclear Generation Division.** Clarke, T.R. (Ont Hydro, Nucl Generation Div). pp 3-5 of Canadian Nuclear Association--annual international conference proceedings, 17, Volumes 1 through 6, 1977. Montreal; Canadian Nuclear Association (1977).

From 17. annual international conference of the Canadian Nuclear Association; Montreal, Ontario, Canada (5 Jun 1977).

Ontario Hydro's Nuclear Generation Division operates a diverse range of facilities, including CANDU PHW generating stations, heavy water plants, radioactive waste management, and an oil fired steam plant. The Nuclear Generation Division's environmental protection program identifies each facility's emission and environmental impact, measures and monitors the emissions, devises objective standards and controls the emission impact by developing operating procedures and targets. Radioactivity, heat and sulphur compounds are the major emissions common to nuclear facilities and are used in this paper to illustrate the operations of the environmental protection program. 1 ref.

35210 **Preoperational environmental radiation monitoring at Point Lepreau.** Paciga, J.J.; Burnham, J.U.; Flanigan, J.A.; McGregor, A.T. (NB Electr Power Comm). pp 6-7 of Canadian Nuclear Association--annual international conference proceedings, 17, Volumes 1 through 6, 1977. Montreal; Canadian Nuclear Association (1977).

From 17. annual international conference of the Canadian Nuclear Association; Montreal, Ontario, Canada (5 Jun 1977).

Point Lepreau Generating Station is a 600 MW(e) CANDU nuclear reactor currently under construction on the Bay of Fundy approximately 40 km southwest of Saint John, New Brunswick. Since it will be the first nuclear station in Canada to use seawater for condenser cooling, a comprehensive preoperational environmental monitoring program has been initiated. This paper is an extended abstract describing the environmental programs at Point Lepreau, including radionuclide monitoring of air, ground, and seawater samples.

SITING

35211 (NP—22896) **Application of demography to energy facility development projects. Working Paper No. 39.** Krannich, R.S.; Stanfield, G.G. (Pennsylvania State Univ., University Park (USA). Center for the Study of Environmental Policy). 15 Sep 1977. 21p. State Univ., University Park.

The emergence of concern regarding socioeconomic consequences of large-scale development projects has resulted in a growing literature directed as estimating the types and levels of various impact dimensions which can be expected to result in human communities experiencing such development. Among these dimensions, a focus on population change has been prevalent. Accurate demographic predictions may be viewed as critical for the adequate comprehension of and preparation for impacts deriving from projects such as energy facility developments. Unfortunately, the state of the art in

projecting demographic consequences of energy projects has been generally inadequate. Several of the more influential prior methods for estimating local demographic effects of developing energy facilities are critiqued, although their specific prediction figures are not summarized. The studies reviewed were found to be of dubious practical utility, probably due in part to the failure of basic demography to provide a base of support for applied demographic research. This report sets forth recommendations for the development of a theoretical perspective which would more adequately serve the needs of practitioners attempting to predict local demographic effects of energy facility development.

RADIOACTIVE EFFLUENTS

35212 (KFK—2421) **Releases of $^{14}CO_2$ from nuclear facilities with gaseous effluents.** Schuettelkopf, H. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Abt. Strahlenschutz und Sicherheit). Jun 1977. 11p. (In German). Dep. NTIS (US Sales Only), PC A02/MF A01.

The ^{14}C stack vent emission from various facilities has been measured. The measurement was restricted to $^{14}CO_2$, because it is only this compound which can lead to exposure doses as a result of ingestion and inhalation. Sampling and radiochemical sample preparation are described. The $^{14}CO_2$ emission was measured in the stack vent air of the FR-2, the MZFR, the combustion facility for burnable radioactive waste (FERAB), the WAK and in the exhaust air of the KWO and Biblis A.

35213 (NRPB-R—53) **Estimate of the radiological consequence of notional accidental releases of radioactivity from a fast breeder reactor.** Kelly, G.N.; Jones, J.A.; Hunt, B.W. (National Radiological Protection Board, Harwell (UK)). Aug 1977. 168p. Dep. NTIS (US Sales Only), PC A08/MF A01.

Available from H.M. Stationery Office, price Pound3.50.

An assessment is made of the radiological consequences of accidental releases of activity from a fast breeder reactor under certain circumstances. It was prepared under contract to the Nuclear Installations Inspectorate (Health and Safety Executive) to assist them in making a preliminary safety assessment of fast reactors. The range of releases considered was specified by the Inspectorate and comprises the vaporisation and release of varying fractions of the core of a 1300 MW(e) reactor. Two cases are evaluated depending on assumptions relating to the remainder of the core. No attempt is made to assign any probability to the occurrence of a given release; the report provides no more than a part of the information necessary for a safety assessment and is to be considered only within this limited context.

35214 (STH—2/77) **Measurement of the nuclide composition of radioactive rare gases in the vent air of the nuclear power plant Biblis, Unit A.** Winkelmann, I.; Haubelt, R. (Bundesgesundheitsamt, Neuherberg (Germany, F.R.). Inst. fuer Strahlenhygiene). Jan 1977. 25p. (In German). Dep. NTIS (US Sales Only), PC A02/MF A01.

It is reported on the results of measurements for determining the individual nuclides of radioactive rare gases in the vent air from the stack of the nuclear power plant Biblis Unit A in the year 1976 in normal operation. Further, based on the measured release rates of radioactive rare gases, the radiological exposure by radioactive rare gases of the population in the environment of the nuclear power plant is assessed. A mean γ-dose factor of 1.3×10^{-5} rem x m^3/G x sec and a mean β-dose factor of 0.036 rem x m^3/G x sec is evaluated. From these results for the whole body dose by γ-submersion at a distance of 100 m from the stack, a maximum value of 0.04 mrem/y, and for the skin dose by β-submersion at the point of maximum concentration at a distance of 500 m, a value of 0.02 mrem/y were determined.

35215 **Radioactive effluents from nuclear installations in the FRG in 1975.** *Atomwirtsch., Atomtech.;* **22**: No. 11, 592-595(Nov 1977). (In German).

The information is summarized from the Federal Government Report on 'Environmental Radioactivity and Radiation Exposure in the year 1975' set up by the BMI, which is related to the effects of nuclear facilities (nuclear power plants, nuclear research centres and nuclear fuel processing), and these are compared to other population exposure risks. Occupational exposure is also considered here.

35216 **Method of waste management for a nuclear power plant.** (to Steinmueller (L. u. C.) G.m.b.H., Gummersbach (Germany, F.R.)). German(FRG) Patent 2,554,256/A/. 16 Jun 1977. 12p. (In German).

The invention deals with decentralized management of radioactive waste from nuclear power plants. For this purpose a method is proposed by which the volume of activated and/or contaminated parts is first of all reduced to an extent permitting the use of safety and auxiliary systems already existing in the plant and the installation of additional systems for treatment at low cost. The volume reduction consists in fragmentation of the parts in portions by means of cutting, flame-cutting, and machining at the point of dismounting or in the storage pool. Further treatment like pressing, melting down, deep-freezing with subsequent crushing, or chemical treatment of the contaminated material will follow before it will be packed and transported away. The inventions further provide for decontamination of the parts before or after volume reduction.

35217 **Improved liquid waste processing system of PWR plant.** Suehiro, K. (Mitsubishi Heavy Industries Ltd., Kobe (Japan). Kobe Shipbuilding and Engine Works). *Karyoku Genshiryoku Hatsuden;* **28**: No. 1, 47-54(Jan 1977). (In Japanese).

Mitsubishi Heavy Industries, Ltd. has engaged in the improvement and enhancement of waste-processing facilities for PWR power stations, and recently established the improved processing system. With this system, it becomes possible to contain radioactive waste gas semi-permanently within plants and to recycle waste liquid after the treatment, thus to make the release of radioactive wastes practically zero. The improved system has the following features, namely the recycling system is adopted, drain is separated and each separated drain is treated by specialized process, the reboiler type evaporator and the reverse osmosis equipment are used, and the leakless construction is adopted for the equipments. The radioactive liquid wastes in PWR power stations are classified into coolant drain, drain from general equipments, chemical drain and cleaning water. The outline of the improved processing system and the newly developed equipments such as the reboiler type evaporator and the reverse osmosis equipment are explained. With the evaporator, the concentration rate of waste liquid can be raised to about three times, and foaming waste can be treated efficiently. The decontamination performance is excellent. The reverse osmosis treatment is stable and reliable method, and is useful for the treatment of cleaning water. It is also effective for concentrating treatment. The unmanned automatic operation is possible.

RESEARCH, TEST, AND EXPERIMENTAL REACTORS

REFER ALSO TO CITATION(S) 35254, 35255

35218 (CEA-CONF—3926) **Measurement and computation of gamma heating in Osiris.** Morin, C. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Services des Piles). Jan 1977. 44p. (In French). (CONF-770479—1). Dep. NTIS (US Sales Only), PC A03/MF A01.

From 44. meeting of the French groups for dosimetry; Strasbourg, France (21 Apr 1977).

The results presented are from a campaign of measurements effected at the ISIS reactor using a four-head differential calorimeter developed in the 'Services des Piles' at Saclay. These results are compared with the computations effected using the three-dimensional MERCURE 4 code. The whole set of gamma sources were taken into account for this computation. Results compared are in good agreement inside the core. At the periphery, outside the vessel, the computed heating values are about 15% higher than the measured ones.

35219 (HEDL-SA—1348) **Development of ultrasonic examination methods for austenitic stainless steel weld inspection.** Mech, S.J.; Michaels, T.E.; Emmons, J.S.; Sugiyama, M.M. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Aug 1977. Contract EY-76-C-14-2170. 29p. Dep. NTIS, PC A03/MF A01.

Signal acquisition and analysis techniques were developed to permit locating notches placed in an austenitic stainless steel pipe weld. Ultrasonic techniques presented here utilized refracted longitudinal and shear inspection beams with a dual element, pitch-catch transducer. Sources of grain noise and the metallurgical iplications of inspecting austenitic stainless steel welds are reviewed. Data were analyzed in both time and frequency domains, and a simple frequency moment algorithm was developed which is sensitive to defect signal and somewhat insensitive to grain noise. Data were also used to train an adaptive learning network (ALN) and the results obtained demonstrate only slight sensitivity to grain noise.

35220 (HEDL-TME—77-91) **Three-dimensional inelastic analysis of a small liquid sodium valve.** Weiner, E.O. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Feb 1978. Contract EY-76-C-14-2170. 198p. .

Portions of document are illegible.

A three-dimensional inelastic analysis of a small liquid sodium valve for the Fast Flux Test Facility was conducted to assess ratcheting and creep damage at temperatures to 1200°F using the MARC-CDC finite element program. A single mesh of twenty-node solid elements, representing the Y-type cylinder intersection is used for both the heat transfer and mechanical computer runs. Material behavior is governed by kinematic and creep strain hardening, and the loading consists of steady mechanical loads with cyclic fluid thermal transients. The resulting creep damage is significantly small-

er than that of a corresponding axisymmetric analysis, and plastic strains are confined to a single region.

35221 (HEDL-TME—77-107) **Detection of feedback resonances in FFTF using rod drop stability tests.** Harris, R.A. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Feb 1978. Contract EY-76-C-14-2170. 24p. .

An analysis is presented of simulated rod drop experiments in the Fast Flux Test Facility using reactor models with unanticipated resonant behavior. The analysis shows that a narrow resonance in the reactor transfer function should be detected if it resulted in an increase in the frequency response function gain of 26% over the gains at nearby frequencies. This detection level assumes no prior knowledge of the resonance and no attempt to model it in the analysis. Changes in the total reactor frequency response function gain of approximately 13% are shown to be detectable if consistent experimental data before and after the change are available.

35222 (LA—7121-H) **Thirty years at Pajarito Canyon Site.** Paxton, H.C. (Los Alamos Scientific Lab., N.Mex. (USA)). Mar 1978. Contract W-7405-ENG-36. 59p. Dep. NTIS, PC A04/MF A01.

A brief historical account of the critical experiments at the Pajarito Canyon site at Los Alamos from the 1940s to the present is presented. Numerous photographs are included.

35223 (LMEC—77-8) **Demonstration of contact and plugging tube type leak detector performance in FFTF reactor inlet guard pipe.** Klea, J.A. (Liquid Metal Engineering Center, Canoga Park, Calif. (USA)). 31 Jan 1978. Contract EY-76-C-03-0700. 87p. .

The performance (response) of a contact and plugging tube type leak detector was evaluated in a heated and inerted pipe mockup of the reactor inlet piping system in the vicinity of the inlet nozzle and guard vessel annulus. Other than an initial test at 600°F (315.6°C) and the last test at 400°F (204.4°C), the tests were run at 680°F (360°C) with 1 percent O_2 and 1000 ppM (vol) moisture. A leak rate system was designed to permit liquid sodium to leak from the inside radius surface of the inlet pipe onto the bottom of the guard pipe. Leak rates were varied in the 50- to 800-g/h range. The behavior and nature of the sodium was evaluated and photographed by disassembling the pipe mockup following each test.

35224 (LTR—129-12) **Radiation levels during operation.** Maringas, N. (Idaho National Engineering Lab., Idaho Falls (USA)). 3 Mar 1978. Contract EY-76-C-07-1570. 17p. Dep. NTIS, PC A02/MF A01.

Portions of document are illegible.

For full-power operation, the four major sources of radiation are: neutrons and gamma rays penetrating the sides of the shield tank; nitrogen-16 activity in the primary coolant; radiation leakage up and down the space between the reactor vessel and shield tank and scattering to accessible areas; and gamma rays from inelastic scattering of fast neutrons in the core. These four sources are discussed, and calculated radiation levels in important areas are given.

35225 (LTR—144-12) **LOFT PSMG Speed Control System frequency response analysis.** Hansen, H.R. (Idaho National Engineering Lab., Idaho Falls (USA)). 30 Dec 1977. Contract EY-76-C-07-2170. 21p. Dep. NTIS, PC A02/MF A01.

Portions of document are illegible.

An analysis was done to gain insight into the shape of the open loop frequency response of the PSMG Speed Control System. The results of the analysis were used as a guide to groom the proportional band and reset time settings of the 2 mode controller in the speed control system. The analysis shows that when an actuator with a timing of 90 degrees per 60 seconds is installed in the system the proportional band and reset time should be 316% and 1 minute. Whereas when grooming the system a proportional band and reset time of 150% and 1.5 minutes were found to be appropriate. The closeness of the settings show that even though a linear model was used to describe the non-linear PSMG Speed Control System, it was accurate enough to be used as a guide to groom the proportional band and reset time settings.

35226 (TID—28305) **LOFT monthly progress report for October 1977.** (Idaho National Engineering Lab., Idaho Falls (USA)). Nov 1977. Contract EY-76-C-07-1570. 125p. Dep. NTIS, PC A06/MF A01.

Following core load the primary activities in the LOFT Facility were the stackup and checkout of the fuel inspection vessel spool pieces. The stackup and checkout operations went as scheduled with minor exceptions. The updated work plan and performance measurements baseline plan were completed and released. The Program Management Information System (PMIS) task force has issued the initial eight procedures, and a Performance Measurement System (PMS) Users Manual. Additional procedures and documentation, covering the remaining elements of PMIS will follow. Together these will constitute the complete LOFT PMIS manual.

35227 **Multidimensional space—time nuclear reactor kinetics studies. III. Three-dimensional experiments.** Winn, W.G.; Parks, P.B.; Baumann, N.P.; Jewell, C.E. (Savannah River Lab., Aiken, SC). *Nucl. Sci. Eng.;* **65**: No. 2, 254-272(Feb 1978).

Unsymmetric perturbations were introduced into the core of a large, critical, heavy-water-moderated, multiregional reactor. The resulting three-dimensional changes in flux level and shape with time were measured. Perturbations included: (1) free-fall insertion of rods near the reactor center with each rod containing ^{235}U slugs in the bottom half and lithium slugs in the top half, (2) free-fall insertion of rods into an off-center radial position with each rod containing ^{235}U slugs in the bottom half and aluminum in the top half, and (3) withdrawal of cadmium control rods from the central 20% of the reactor core. Flux tilts calculated with the TRIMHX code were within 5% of measured flux tilts. TRIMHX provides a three-dimensional (hex-z geometry) solution of the few-group neutron diffusion and delayed precursor equations without feedback. Inputs to the calculations are available in sufficient detail to allow other methods of solution to be tested.

35228 **Pinhole imaging of a test fuel element at the Transient Reactor Test Facility.** Berzins, G.J.; Han, K.S. (Los Alamos Scientific Lab., NM). *Nucl. Sci. Eng.;* **65**: No. 1, 28-40(Jan 1978).

Neutrons and gamma rays emitted by a test fuel element were imaged through a linear array of pinholes. The ionizing radiations formed optical images on a plastic scintillator that was viewed by an intensified television (TV) system. The TV records provided a sequence of twelve 16-ms frames spanning a 2860-MW, 315-MW-s Transient Reactor Test Facility transient. Data show radial expansion of the test fuel pin.

35229 **Measurement of the neutron spectrum from a fast pulse reactor in the presence of the experimenter's table.** Harvey, J.T. (Univ. of Arkansas, Fayetteville); Meason, J.L.; Wright, H.L. *Nucl. Sci. Eng.;* **65**: No. 1, 160(Jan 1978).

The measurement of the neutron spectrum from the White Sands Missile Range Fast Burst Reactor (FBR) in the presence of the experimenter's table is reported. A reinvestigation of this neutron spectrum was performed as a result of a recently published work, which indicates that the experimenter's table has a considerable softening effect on the neutron spectrum from the FBRF. Based on such spectral parameeters as average energy, integral fluence, and spectral index, we find the neutron spectrum associated with the experimenter's table to be essentially identical to the free-field leakage spectrum.

35230 **Experiments carried out in the RB-2 reactor by null reactivity oscillator method on HTR lattices. Part 1. Experiment feasibility and RB-2 reactor modifications.** Benedetti, F.; Brighenti, G.; Chiodi, P.L.; Giuliani, C. (AGIP Nucleare, Laboratori di Montecuccolino, Bologna Italy); Chilardotti, G. (AGIP Nucleare, Milan (Italy)). *Energ. Nucl. (Milan);* **24**: No. 2, 73-88(Feb 1977).

A dynamic version of the null reactivity method, called the "null reactivity oscillator method", was implemented and tested in the RB-2 reactor of Montecuccolino, Bologna (Italy). The reactor was completely redisigned and rebuilt to this purpose. The method was tested on a low enrichment, high temperature reactor lattice. The work is described into two part: part 1, which coincides with this article, includes the results of the experiment feasibility study and the description of the modified RB-2 reactor; part 2, which will appear later, will cover the actual measurements on the HTR lattice. More in detail, part 1 illustrates the principles of the null reactivity oscillator method and the problems posed by its implementation in the RB-2 reactor. The results of the feasibility study are given, together with a description of the main reactor modifications. Finally the main design and operating characteristics of the reactor, of the control system, of the oscillation system, and of the system for measuring and recording the reactor power modulation are illustrated.

35231 **Absolute fission ratio measurements with semi-conductor fission chambers.** Hirakawa, N.; Baba, M.; Kanda, K.; Yokoyama, T. (Tohoku Univ., Sendai (Japan). Faculty of Engineering). *Technol. Rep. Tohoku Univ.;* **41**: No. 2, 447-463(Dec 1976).

For the purpose of measuring absolute fission ratios in fast critical assemblies, fission chambers using semi-conductor detectors were prepared. By electrical deposition, thin homogeneous foils of U-233, U-235, natural uranium and neptunium-237 were obtained. The effective number of fissile atoms was determined both by alpha particle countings and by fission event recordings in standard thermal neutron column. Except for natural uranium chambers the determined effective number of atoms agreed within experimental errors. The detectors were used to measure equilibrium spectrum in the natural uranium blocks and the fast reactor spectrum in a fast critical core (FCA VI-2). The results were compared with those of other laboratories and those of calculation. It was found that the fission chambers of this type would be of practical use in fast reactor critical experiment.

35232 **Some physical studies on the BFS-1 fast critical assemblies.** Dulin, V.A.; Kazanskii, Yu.A.; Mamontov, V.F.; Sidorov, G. I. *At. Energ. (USSR);* **40**: No. 5, 377-381(May 1976). (In Russian).

A check has been carried out of nuclear-physical constants and methods of calculation to make more accurate predictions of the main physical characteristics of fast reactors using BFS-22, 26, 27, 28, 30 critical assemblies. The central reactivity coefficients have been measured for ^{235}U, ^{238}U, ^{239}Pu, ^{10}B, ^{197}Au, ^{6}Li, ^{1}H, ^{12}C, ^{23}Na, Pb. Measurement has been taken of the ratio of the value function of nascent neutrons to that of neutron absorption as well as reaction rate ratios of a number of fissile and absorbent elements. A brief description is given of BFS critical assemblies, and the experimental techniques. Methods of introducing corrections have been checked. The main experimental results and the results of the calculations made are given. The experimental data have been compared with the results of calculations on the basis of a 26-group programme using the BNAB-70 system of constants.

PROPULSION REACTORS

35233 (CEA-CONF—3933) **In-service inspection of the vessels of nuclear submarine reactors.** Saglio, R.; Mercier L'Abbe, G. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Technologie). Feb 1977. 22p. (In French). (CONF-7705114—1). Dep. NTIS (US Sales Only), PC A03/MF A01.

From Meeting of the Maritime and Aeronautical Association; Paris, France (5 May 1977).

Description is given of a machine of automatic inspection of the reactor vessels of nuclear submarines, that was developed by the French Atomic Energy Commission (CEA). A focused ultrasound testing method is used. The equipment such described meets the safety requirements prescribed for the primary circuits of nuclear submarine boiler plants. The sensitivity and resolution power of the apparatus allow such high precision to be obtained as rupture mechanics gains a credibility that could not have been obtained with using conventional apparatus.

35234 (GKSS—77/E/14) **Collision experiments of GKSS.** Woisin, G. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Hamburg (Germany, F.R.)). 1977. 4p. (In German). Dep. NTIS (US Sales Only), PC A02/MF A01.

Available from ZAED.

The aim of the experiments carried out was the development of a novel collision protection, capable of being licensed, for large reactor ships. This protecting construction of the so-called resistance-type consists of a network structure between hull plating and wing-passage bulkhead. This protection, offering itself for other double-hull ships, too, stood the tests in excellent manner.

35235 **Gaseous fuel reactor research.** Thom, K.; Schneider, R.T. (National Aeronautics and Space Administration, Washington, DC). *IEEE Trans. Plasma Sci.;* **PS-5**: No. 4, 259-272(Dec 1977).

Gaseous Fuel Nuclear Reactors are externally moderated and contain the fissile material inside a cavity where it is suspended by fluid mechanics forces. The gaseous phase of the nuclear fuel permits operation of the reactor at temperatures much higher than the melting point of all materials. NASA has originally supported relevant research for space propulsion. The continuation of this work includes new research on power generation on Earth for improved economy and environmental acceptability. In reactor experiments with enriched uranium hexafluoride, UF_6, a critical mass of 6 kg is determined. Pressurized UF_6 remains chemically stable at temperatures up to 2000 kelvins. The interaction of fission fragments with their gaseous environment causes preferential excitation and ionization, leading to non-equilibrium optical radiation. Powerful fluxes of photons are expected to become a superior mechanism of energy extraction from the fissioning gas or plasma in the reactor. The pumping of lasers solely by fission fragments is realized in a variety of lasants. A near term objective of the NASA gaseous fuel reactor program is a benchmark experiment at 100 kw power and at a gas temperature of 1600 kelvins, demonstrating the feasibility of major advances in reactor technology. A concerted research effort is leading to this experiment. A plasma core cavity reactor for high specific impulse propulsion in space remains a long range goal.

35236 **Support of nuclear powered vessels in service.** Hammersley, P.G.; Thomas, P.A.M. pp 74-81 of IMAS 76 proceedings part 2. London; Marine Media Management (1976).

From International marine and shipping conference; London, UK (27 Apr 1976).

See CONF-7604146—P2.

The possibility of powering a merchant ship by means of a nuclear steam raising plant has been considered for some years, but shipowners have always been deterred by the high capital costs involved compared with conventionally powered ships. Within the last two years, however, the price of fuel oils has risen so sharply that the economics of nuclear power are now more attractive and it is becoming increasingly evident that alternative fuels should be sought to reduce the depletion of the world's oil reserves. Further costing exercises have been commissioned to review the part that nuclear power can play in the role of marine propulsion. But a change to a nuclear power plant entails a completely new attitude to ship operation. The nuclear safety requirements impose a need for much higher standards of design, manufacture, operation and support than is necessary for conventional ships.

35237 **Towards a nuclear merchant ship.** Nicholson, R.L.R.; Llewelyn, G.I.W.; Farmer, A.A. (UKAEA). pp 82-87 of IMAS 76 proceedings part 2. London, UK; Marine Media Management (1976).

From International marine and shipping conference; London, UK (27 Apr 1976).

See CONF-7604146—P2.

The operation of nuclear merchant ships is likely to be attended by a number of constraints and requirements. Not all of these can be fully resolved until such ships come into use and the necessary experience and confidence have been acquired. But the timing of commercial introduction, if it comes about, will depend on the relative economics of nuclear versus fossil fuel propulsion, and the differences in turn depend in part on the operating costs particular to nuclear ships. This paper; i) reviews some of the operational aspects as seen in the U.K.; ii) summarizes views received by the Nuclear Merchant Ship Unit (NMSU) from U.K. shipping, shipbuilding and nuclear industries on the prospects of a U.K. nuclear merchant ship.

REACTOR SAFETY

REFER ALSO TO CITATION(S) 35539, 36147

35238 (AAEC-LIB/Trans—600) **Development of methods for the mass flow measurement of non-stationary two-phase flows.** Loffel, R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Feb 1977. 18p.p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The procedure of approval for light water reactor designs requires the designer to demonstrate, that in the case of an accident involving the loss of the coolant the resulting dynamic stresses do not lead to a deformation of fuel elements and reactor pressure vessel components to a degree which would place at risk the proper function of emergency cooling installations and the reliable shut down of the reactor. Due to a sudden pressure drop the escaping, strongly accelerated, primary coolant is in thermo-dynamic non-equilibrium and as such acquires a critical out-flow velocity associated with the formation of an unrestrained jet and the development of steam. Decompression waves travelling in the opposite direction are coupled with these events. These waves place an additional stress on the components of the reactor pressure vessel (PDB). Furthermore local pressure differences and pressure waves, caused by the blow-down flow, produce a large strain on the core containment vessel and on the support structure of the reactor core. These effects are influenced to a large degree by the non stationary two phase mass flow.

35239 (AAEC-LIB/Trans—616) **Behavior of fission products observed during the operation of the C.E.N. Saclay reactors.** Lebauleux, P.; Petitcolas, H. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Feb 1977. 16p.p. (CONF-691104—8). Dep. NTIS (US Sales Only), PC A02/MF A01.

From International congress on the diffusion of fission products; Saclay, France (4 Nov 1969).

Three experimental reactors are in use at C.E.N. Saclay, (1969): one heavy water type with slightly enriched uranium oxide fuel (EL3, 18MW) and two light water pool types with highly enriched plate fuel (OSIRIS, 70MW and ISIS, 800KW). The following incidents occurred during operation of these reactors : fuel cladding failures, particularly on EL3, release of fission products as a result of the handling of irradiated fuel elements, a power excursion associated with a partial fuel element melt-down on ISIS. The authors summarize the results which have been obtained on the behaviour of fission products released during the above incidents.

35240 (ANL—78-23) **Physics of reactor safety. Quarterly report, October—December 1977.** (Argonne National Lab., Ill. (USA)). Mar 1978. Contract W-31-109-ENG-38. 32p. Dep. NTIS, PC A03/MF A01.

Work on the reactor safety program includes Monte Carlo analysis of safety-related critical assembly experiments by members of the Theoretical Fast Reactor Physics Group, and Planning of Safety-Related (ZPR) Planning and Experiments Group. Work on reactor core thermal-hydraulic code development performed in the Components Technology Division is also included.

35241 (CRBRP-ARD—0132) **Clinch River Breeder Reactor Plant. A preliminary evaluation of the CRBRP natural circulation**

decay heat removal capability. Lowrie, R.R.; Severson, W.J. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Nov 1977. Contract EY-76-C-15-2395;EY-76-C-15-0003. 291p.

Using the "LMFBR Demonstration Plant Simulation Model (DEMO)" a preliminary evaluation of the Clinch River Breeder Reactor Plant decay heat removal capability by natural circulation has been made. This assessment was made in response to the design requirement that, although the plant is a forced circulation plant, emergency cooling shall be based on natural circulation in all main heat transport loops. Based on this evaluation, the preliminary conclusions are: (1) The arrangement of components within the plant (i.e., the relative elevations of the IHX with respect to the core, the steam generator modules with respect to the IHX and the steam drum with respect to the evaporator modules) will provide thermal driving heads necessary to promote adequate flows in the natural circulation mode. (2) The specified pump coastdown characteristics satisfy the minimum flow decay requirements immediately following a plant trip. (3) While the CRBRP is a forced circulation plant, its heat transport and steam generator systems will provide a desirable margin in decay heat removal by their natural circulation capability.

35242 (ECN—22) **Fast reactor programme. First quarter 1977 progress report.** Hoekstra, E.K. (Stichting Energieonderzoek Centrum Nederland, Petten). Jul 1977. 50p. Dep. NTIS (US Sales Only), PC A03/MF A01.

Results of central reactivity worth measurements on various fission product nuclides performed in STEK at Petten are compared with results of integral activation measurements performed on same in CFRMF at Idaho. Post-irradiation examination results are given of a burst fuel pin (R54-F36) fitted with a stainless steel DIN 1.4981 canning, and loss-of-cooling experiment R63-L14. The outcome of several thermal diffusivity measurements on 14 pellets of U(C,N) is reported. Results of low-cycle fatigue experiments on creep-conditioned specimens of stainless steel DIN 1.4948 are discussed. A study on the leakage of aerosol particles through cracks and ducts in a reactor containment wall is proposed. In the field of heat transfer and hydraulics, reports are given on a singlephase experiment using a thin-walled heater NANCY-054, Laser Doppler Anemometer measurements on water flowing through a square channel, temperature noise measurements, and a study of local boiling behind a flow blockage in a 28-rod bundle.

35243 (EPRI-NP—526(Vol.2)) **Transient deformation properties of Zircaloy for LOCA simulation. Volume 2. Final report.** Hann, C.R.; Mohr, C.L.; Busness, K.M.; Olson, N.J.; Reich, F.R.; Stewart, K.B. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Mar 1978. Contract EY-76-C-06-1830. 280p. Dep. NTIS, PC A13/MF A01.

The creep/creep rupture anisotropic properties of Zircaloy were determined and compared by analytical techniques with ramp-pressure and ramp-temperature test results. Tests were performed over the temperature range of 600°F (589 K) to 2200°F (1477 K), with the emphasis on the 800°F (700 K) to 2000°F (1366 K) temperature levels in low pressure air (6.5×10^{-5} atm) and in a 1 atm mixture of 20% oxygen, 80% argon. Stress levels of 60 to 95% of the ultimate tensile stress were used for the majority of the tests at each of the temperature levels tested, with selected tests performed as low as 30% of the ultimate tensile stress. Biaxial and uniaxial testing modes were used to evaluate the anisotropic deformation behavior. The combination of test results and predictive-analysis techniques developed as part of this program make it possible to predict the transient deformation of reactor fuel cladding during simulated LOCA conditions. Results include creep/creep rupture strain numerical constitutive relationships out to 120 seconds, computer codes and ramp test data.

35244 (GRS-F—39) **List of reports on reactor safety research by the BMFT and the USNRC. Period under review: 1 January—31 March 1977.** (Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Koeln (Germany, F.R.)). May 1977. 57p. (In German, English). Dep. NTIS (US Sales Only), PC A04/MF A01.

This list reviews reports from the Federal Republic of Germany and from the United States of America concerning special problems in the field of Reactor Safety Research which have been collected in the Gesellschaft fuer Reaktorsicherheit. The list pursues the following order: Country of origin, problem area concerned according to the Reactor Safety Research Program of BMFT, reporting organisation. The list or reports appears quarterly. This edition contains all reports as registered from January through March 1977.

35245 (JAERI-M—6869) **Influence of deformation on the subsequent steam oxidation of zircaloy cladding.** Furuta, T.; Kawasaki, S.; Hashimoto, M.; Otomo, T. (Japan Atomic Energy Research Inst., Tokyo). Jan 1977. 20p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

Concerning the influence of deformation on the oxidation of zircaloy cladding under a loss-of-coolant accident condition, the subsequent oxidation after deformation has been studied by sham fuel-rod burst and high-temperature tensile tests in a steam flow. In high-temperature tensile test, tensile deformed specimens in the temperature range of 700° - 900°C and the undeformed ones were exposed, at the same time, to steam at 1000°C. Oxidation kinetics were examined using metallographic methods. Deformation before the subsequent oxidation results in increase of the growing oxide. Apparent thickness of the growing oxide depends on temperature and degree of the deformation. The growing oxide is composed of monoclinic and tetragonal zirconia, the fraction of which is influenced by extent of the deformation. Severe oxygen penetration as well as increase of the growing oxide, is found in the rupture lips of deformed specimens.

35246 (JAERI-M—6879) **Zircaloy-steam reaction and embrittlement of the oxidized zircaloy tube under postulated loss of coolant accident conditions. Oxidation kinetics and embrittlement of zircaloy at above 1200sup(O)C.** Suzuki, M.; Kawasaki, S.; Furuta, T. (Japan Atomic Energy Research Inst., Tokyo). Jan 1977. 23p. (In Japanese). Dep. NTIS (US Sales Only), PC A03/MF A01.

Zircaloy-Steam reaction and embrittlement of the Zircaloy tube have been studied under postulated Loss of Coolant Accident conditions. Over the reaction temperature range of 1184 to 1330°C, the weight gain, oxide and xi layer thickness changes proved to follow a parabolic rate law. The reaction constants at above 1000°C are: K sub(p)=0.468exp(-40710/RT) (gm/cm^2)²/sec K sub(delta)=0.02150exp(-35860/RT) (cm^2/sec) K sub(xi)=0.3960exp(-39420/RT) (cm^2/sec) Ductility change of the oxidized specimens was examined at 100°C by ring compression test. The ductility decreases with increase of the weight gain. For the same weight gain, the ductility of the specimens oxidized at high temperature is lower than those at low.

35247 (JAERI-M—7106) **ROSA-II test data report, 7. Worse break condition and pump effect (runs 318, 320, 321, 322, 323).** (Japan Atomic Energy Research Inst., Tokyo). Jun 1977. 181p. (In Japanese). Dep. NTIS (US Sales Only), PC A09/MF A01.

Results of the ROSA-II test simulating a loss-of-coolant accident (LOCA) in a light water reactor (LWR) are presented, including the test conditions and interpretation of the phenomena for test runs 318, 320, 321, 322 and 323.

35248 (Juel—1362) **Thermodynamic correlations for the accident analysis of HTR's.** Rehm, W.; Jahn, W.; Finken, R. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Nukleare Sicherheitsforschung). Dec 1976. 132p. (In German). Dep. NTIS (US Sales Only), PC A07/MF A01.

The thermal properties of Helium and for the case of a depressurized primary circuit, various mixtures of primary cooling gas were taken into consideration. The temperature dependence of the correlations for the thermal properties of the graphite components in the core and for the structural materials in the primary circuit are extrapolated about normal operation conditions. Furthermore the correlations for the effective thermal conductivity, the heat transfer and pressure drop are described for pebble bed HTR's. In addition some important heat transfer data of the steam generator are included. With these correlations, for example accident sequences with failure of the afterheat removal systems are discussed for pebble bed HTR's. It is concluded that the transient temperature behaviour demonstrates the inherent safety features of the HTR in extreme accidents.

35249 (Juel—1404) **Investigation on depressurization in the primary circuit of a pebble bed high-temperature reactor after break of the main coolant duct.** Schaefer, M. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung; Technische Hochschule Aachen (Germany, F.R.)). Mar 1977. 86p. (In German). Dep. NTIS (US Sales Only), PC A05/MF A01.

Thesis.

In high-temperature reactors of the non-integrated type there is the possibility of failure for those pressure-sustaining components, which lie outside of the unburstable prestressed concrete pressure vessel. The severest imaginable depressurization accident is the double-ended break of one gas duct, which connects the reactor with the steam generator. As a consequence of this failure there will develop pressure differences acting on structural components of the primary circuit. These pressure differences are calculated with a multi-node computer model. The mechanical behaviour of the endangered components is estimated and improvements of the construction are proposed.

35250 (KFK-EXT—7/76-2) **Operation method of the X-ray equipment for the investigation of the ballooning of LWR-fuel rod simulators.** Mueller, S.; Thun, G. (Kernforschungszentrum Karlsruhe (Germany, F.R.). Inst. fuer Reaktorbauelemente; Kernforschungszentrum Karlsruhe (Germany, F.R.). Projekt Nukleare Sicherheit). Jun 1977. 9p. (In German). Dep. NTIS (US Sales Only), PC A02/MF A01.

X-Ray-equipment is described which has been selected and assembled for the recording of fuel rod simulator-deformations during a loss of coolant accident using a movie technique. With this method it is possible to observe and record the ballooning of the simulator under conditions similar to those in a reactor. Some typical pictures are shown which show that the quality is high enough to allow a quantitative evaluation of the ballooning as a function of time.

35251 (LA-UR—78-495) **Role of mechanistic analysis in providing PAHR initial conditions.** Jackson, J.F. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 3p. (CONF-771108—9). Dep. NTIS, PC A02/MF A01.

From Post accident heat removal information exchange meeting; Chicago, IL, USA (2 Nov 1977).

The objective of this paper is to discuss how Postaccident Heat Removal (PAHR) calculations interface with the earlier accident phases in overall mechanistic accident analyses, to briefly review the evolution of the transition phase as an important path in LMFBR core disruptive accidents, and to assess the impact of the transition phase on PAHR analyses.

35252 (LA-UR—78-805) **Application of statistical techniques to the analysis of reactor safety codes.** McKay, M.D.; Bolstad, J.W.; Whiteman, D.E. (Los Alamos Scientific Lab., N.Mex. (USA)). 1978. Contract W-7405-ENG-36. 17p. (CONF-780507—8). Dep. NTIS, PC A02/MF A01.

From Probabilistic analysis of nuclear reactor safety; Los Angeles, CA, USA (8 May 1978).

The objectives of this study on the application of statistical techniques to the analysis of reactor safety codes are the identification of the input variables which have a significant influence on the output variables (sensitivity analysis) and the determination of the effect of uncertainty in input values on the output variables. The Latin hypercube sampling (LHS) procedure is presented as an input value selection procedure. The partial rank correlation coefficient (PRCC) coupled with the LHS procedure is presented as a quantitative measure of sensitivity. An examination of the PRCC variability and an analysis of TRAC for a Semiscale test are presented.

35253 (LMEC-TDR—78-3) **Experimental results of sodium-water reaction Test No. 6.** Miller, A.E.; Neely, H.H. (Liquid Metal Engineering Center, Canoga Park, Calif. (USA)). 6 Feb 1978. Contract EY-76-C-03-0700. 511p. .

The sixth (SWR-6) and final sodium-water reaction test of Series I was performed in the Large Leak Test Rig (LLTR) on November 3, 1977. Presented are computer-produced plots of the transient data obtained and the results of the post-test, nondestructive examinations and cleaning of the test article, Atomics International Modular Steam Generator (AI-MSG) and test system. In the five previous tests (SWR-1 through SWR-5), a double-ended guillotine (DEG) rupture was induced in a standard water tube of the AI-MSG. For SWR-6, a special rupture tube with three times the flow area (3-DEG) was installed in the hockey stick of the AI-MSG. Except for the larger H_2O injection rate (approximately 10.5 lbs/sec vs. approximately 4 lbs/sec) resulting from the larger flow areas (of the rupture tube and connecting injection circuit), SWR-6 and SWR-4 conditions essentially were identical. Superheated steam (approximately 700°F/1900 psig) was injected for 3 seconds into sodium (800°F/100 psig) in the hockey stick region of the AI-MSG, 1.75 inches from the upper tube sheet.

35254 (LTR—10-35) **Compliance with LOFT damage criteria, Modes 1—7.** Johnson, R.L. (STAFCO, Inc., Idaho Falls, Idaho (USA)). 27 Jan 1978. Contract EY-76-C-07-1570. 27p. Dep. NTIS, PC A03/MF A01.

Compliance with the damage criteria specified in Section 3.13 of the LOFT Technical Specifications is demonstrated for reactor operating Modes 1-7. Documented analysis and existing Technical Specification constraints are used to show that maximum allowable consequence levels will not be exceeded for planned operations and postulated accident conditions. A potential problem has been identified involving radiation damage to the containment vessel pressure boundary. Specifically, potential gamma doses from steady state operation combined with multiple LOCEs, a limiting fault LOCA, or a LOCA-MHA exceed the damage threshold for the teflon seal rings in the H and V system 9 containment isolation valves.

35255 (LTR—129-14) **Radiation levels from fission products released to the pressure suppression tank.** Maringas, N. (Idaho National Engineering Lab., Idaho Falls (USA)). 3 Mar 1978. Contract EY-76-C-07-1570. 24p. Dep. NTIS, PC A02/MF A01.

This LTR discusses radiation levels associated with a LOCE where the blowdown is directed to the pressure suppression tank.

35256 (MRR-P—24) **DAPSY: a computer program for the pressure wave propagation in reactor cooling systems.** Grillenberger, T. (Technische Univ. Muenchen, Garching (Germany, F.R.). Lab. fuer Reaktorregelung und Anlagensicherung). Oct 1976. 78p. (In German). Dep. NTIS (US Sales Only), PC A05/MF A01.

The computer code DAPSY is developed to calculate pressure wave phenomena in the primary coolant system. For this purpose it is necessary to treat 3-dimensional single-phase and two-phase flow of water and steam. The technique used in DAPSY is the simulation of the real geometry by a pipe network with connected one-dimensional flow paths. The calculation of the unsteady one-dimensional flow is taken from the BLAST code.

35257 (NUREG—0406(Vol.1)) **Methods for prediction of strong earthquake ground motion. Final technical report, October 1, 1976—September 30, 1977.** Trifunac, M.D. (University of Southern California, Los Angeles (USA). Dept. of Civil Engineering). Sep 1977. 254p. NTIS $8.00.

The purpose of this report is to summarize the results of the work on characterization of strong earthquake ground motion. The objective of this effort has been to initiate presentation of simple yet detailed methodology for characterization of strong earthquake ground motion for use in licensing and evaluation of operating Nuclear Power Plants. This report will emphasize the simplicity of the methodology by presenting only the end results in a format that may be useful for the development of the site specific criteria in seismic risk analysis, for work on the development of modern standards and regulatory guides, and for re-evaluation of the existing power plant sites.

35258 (NUREG/CR—0015) **Analysis of aerosol particles undergoing gravitational agglomeration. Annual progress report, December 15, 1976—September 30, 1977.** Loyalka, S.K. (Missouri Univ., Columbia (USA). Coll. of Engineering). Nov 1977. 66p. NTIS $5.25.

Studies are reported of aerosol behavior following an LMFBR reactor core disruption. Highlights of progress in theoretical area have consisted of a clear and consistent formulation of the dynamical equations of motion for the colliding particles. Relevant Drag forces have been identified and methods for obtaining such forces are discussed. A computer program that determines the collision efficiency by solving the equations of motion and numerical experimentation is operational. At present, the Stokesian Drag forces with slip corrections are being used, but other drag forces will be also incorporated. Results obtained to date indicate that for the range of particle sizes studied so far the collision efficiency decreases with decrease in density. An extensive review of previous experimental work on collision efficiency in the atmospheric sciences was completed. Use of both the macroscopic and the microscopic type of experiments is recommended. The former include laser scattering type of work and the latter include similitude type of experiments. The similitude type of experiments is especially suitable for studying the density and shape effects on the collision efficiency, and the necessary apparatus has been assembled at the UMC. Preliminary experimental parameters have been identified, and initial results are expected to be available in the near future.

35259 (ORNL/NUREG/TM—180) **Critical heat flux experimentation in an annular test section.** White, J.D.; Levin, A.E. (Oak Ridge National Lab., Tenn. (USA)). 7 Mar 1978. Contract W-7405-ENG-26. 32p. Dep. NTIS, PC A03/MF A01.

Steady-state critical heat flux experiments have been performed in the Forced Convection Test Facility (FCTF), an annular test section containing a single electrically heated rod, for the purpose of testing the applicability of existing critical heat flux correlations. Good accuracy has been obtained using the MacBeth-Barnett critical heat flux correlation for annuli, corrected for the "stepped cosine" power profile of the heater. The equivalent diameter of the test section, based on the wetted perimeter, is 2.1 cm (0.83 in.); the heated-to-wetted-perimeter ratio is 0.252. The heated length of the heater rod is 366 cm (144 in.). Nominal pressures for the tests have ranged from 7.2 to 15.5 MN/m^2 (1044 to 2250 psia); coolant flow rates have been 0.32 dm^3/sec (5 gpm), 0.63 dm^3/sec (10 gpm), and 1.26 dm^3/sec (20 gpm); and heater powers of 72 kW, 122 kW, and 144 kW have been used. Maximum error in prediction of first observed critical heat flux is 21 percent; rms error is 11.7 percent. Attempts have also been made to predict the occurrence of critical heat flux during blowdowns (depressurization transients) of the FCTF. The results of these predictions are inconclusive at this time.

35260 (ORNL/NUREG/TM—186) **Fission product behavior in LWRs. Quarterly progress report, October—December 1977.** Malinauskas, A.P.; Lorenz, R.A.; Collins, J.L.; Osborne, M.F.; Whatley, S.K.; Towns, R.L. (Oak Ridge National Lab., Tenn. (USA)). Feb 1978. Contract W-7405-ENG-26. 26p. Dep. NTIS, PC A03/MF A01.

Analysis of release data obtained during High Burnup Fuel Test 10 (HBU-10) has been completed. In this test the fuel rod segment was ruptured by internal pressurization at 900°C, at which time the temperature was rapidly increased to 1200°C and maintained at this temperature for 10 min. Approximately 0.061% of the total cesium inventory in the rod segment was released; this was accompanied by the release of about 1.69% of the total ^{85}Kr

inventory. Moreover, about 0.022% of the fuel was ejected from the rod as particulates. The feasibility and conceptual design study for an experimental facility to verify fission product transport computational models has been completed. Although the study focused entirely on a facility which would be employed to verify those aspects of the transport models that dealt with fission product source-term attenuation factors in the primary coolant circuit external to the pressure vessel, the need for a second facility, to simulate conditions within the pressure vessel, was also indicated.

35261 (PNL—2452) **Meteorological evaluation of multiple reactor contamination probabilities for a Hanford Nuclear Energy Center.** Ramsdell, J.V.; Diebel, D.I. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Mar 1978. Contract EY-76-C-06-1830. 53p. Dep. NTIS, PC A04/MF A01.

The conceptual Hanford energy center is composed of nuclear power plants, hence the name Hanford Nuclear Energy Center (HNEC). Previous topical reports have covered a variety of subjects related to the HNEC including: electric power transmission, fuel cycle, and heat disposal. This report discusses the probability that a radiation release from a single reactor in the HNEC would contaminate other facilities in the center. The risks, in terms of reliability of generation, of this potential contamination are examined by Clark and Dowis.

35262 (SRD—126-76) **RELAP5 hydrodynamic model: progress summary, field equations.** Trapp, J.A.; Ransom, V.H. (Idaho National Engineering Lab., Idaho Falls (USA)). Jun 1976. Contract EY-76-C-07-1375. 31p. Dep. NTIS, PC A03/MF A01.

The RELAP5 hydrodynamic model will include a nonequilibrium Drift-Flux formulation with interface tracking capability. This report summarizes the development to date which covers the equilibrium Drift Flux model and interface tracking scheme. Nonequilibrium capability will be added in the next stage of development. The field equations and associated numerical scheme for the equilibrium model have been tested in a pilot computer program. The equations are recorded in the form recommended for incorporation into an experimental version of RELAP4 as a step in the development of RELAP5.

35263 (TID—28306) **Checkout and developmental verification of CONTEMPT4/MOD2.** Metcalfe, L.J.; Hargroves, D.W. (Idaho National Engineering Lab., Idaho Falls (USA)). Feb 1978. Contract EY-76-C-07-1570. 59p. Dep. NTIS, PC A04/MF A01.

Portions of document are illegible.

The checkout and developmental verification of CONTEMPT4/MOD2 was accomplished using a variety of problems which tested all features of the code. All code features performed as designed; verification results closely matched experimental data. CONTEMPT4/MOD2 is ready for release to the public.

35264 (TREE-NUREG—1154) **Experiment data report for Semiscale Mod-1 Tests S-28-7, S-28-9, and S-28-12.** Esparza, V.; Collins, B.L.; Sackett, K.E.; Coppin, C.E. (Idaho National Engineering Lab., Idaho Falls (USA)). Feb 1978. Contract EY-76-C-07-1570. 493p. Dep. NTIS, PC A21/MF A01.

Recorded test data are presented for Tests S-28-7, S-28-9, and S-28-12 of the Semiscale Mod-1 steam generator tube rupture test series. These tests are among several Semiscale Mod-1 experiments conducted to investigate the thermal and hydraulic phenomena accompanying a hypothesized loss-of-coolant accident in a pressurized water reactor (PWR) system. Tests S-28-7, S-28-9, and S-28-12 were conducted from initial conditions of 15 736 kPa and 557 K, 15 754 kPa and 556 K, and 15 704 kPa and 559 K, respectively, to investigate the response of the Semiscale Mod-1 system to a depressurization and reflood transient following a simulated double-ended offset shear of the broken loop cold leg piping. The specific objective of these tests was to refine the definition of the upper limit of steam generator tube ruptures at which high peak cladding temperatures occur, as set by Test S-28-1. During these tests, cooling water was injected into the cold leg of the intact and broken loops to simulate emergency core coolant in a PWR. Thirty (Test S-28-7), 34 (Test S-28-9), and 20 (Test S-28-12) steam generator tube ruptures were simulated by a controlled injection from a heated accmulator into the intact loop hot leg.

35265 (TREE-NUREG—1202) **CONTEMPT4/MOD2: a multicompartment containment system analysis program.** Metcalfe, L.J.; Mings, W.J.; Hartman, J.E.; Crail, A.C. (Idaho National Engineering Lab., Idaho Falls (USA)). Feb 1978. Contract EY-76-C-07-1570. 296p. Dep. NTIS, PC A13/MF A01.

CONTEMPT4/MOD2 is a digital computer program, written in FORTRAN IV, which describes the behavior of multicompartment pressurized water reactor (PWR) containment systems and experimental containment systems subjected to postulated loss-of-coolant accident (LOCA) conditions. The program calculates the time variation of compartment pressures, temperatures, mass and energy inventories, heat structure temperature distributions, and intercompartment mass and energy exchange based on user-supplied values for compartment descriptions, time step and edit controls, and selected problem features. Analytical models available to describe containment systems include models for containment fans and pumps, cooling sprays, fan coolers, heat conducting structures, sump drain, and PWR ice condensers. Dynamic storage allocations (DSA) is used to limit the amount of computer core used for each problem. Optional automatic time step control allows the code to determine time step sizes within limits dictated by the user. Multicompartment capability (up to 999 individual compartments) and generalized, user-oriented input data descriptions permit improved flexibility over previous codes in the CONTEMPT series. Analytical model descriptions, input instructions, and sample problem results are presented.

35266 (TUBIK—53) **Method to determine the effects of inaccuracies in the component data on the reliability characteristics of the system as a whole.** Kamarinopoulos, L. (Technische Univ. Berlin (Germany, F.R.). Inst. fuer Kerntechnik). Dec 1976. 24p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

It is the aim of this paper to describe a general method for determining the effects of data inaccuracies on system parameters. Furthermore, the dependence of system parameters on the type of distribution function chosen for the component data will be studied using realistic examples, and a comparison will be made with the method hitherto employed.

35267 (UCRL—52367(Rev.1)) **Photographic and video techniques used in the 1/5-scale Mark I boiling water reactor pressure suppression experiment.** Dixon, D.; Lord, D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 16 Mar 1978. Contract W-7405-ENG-48. 21p. Dep. NTIS, PC A02/MF A01.

The report provides a description of the techniques and equipment used for the photographic and video recordings of the air test series conducted on the 1/5 scale Mark I boiling water reactor (BWR) pressure suppression experimental facility at Lawrence Livermore Laboratory (LLL) between March 4, 1977, and May 12, 1977. Lighting and water filtering are discussed in the photographic system section and are also applicable to the video system. The appendices contain information from the photographic and video camera logs.

35268 (XN-NF—76-51(NP)(Suppl.2)) **Flow blockage and exposure sensitivity study for ENC D.C. Cook Unit 1 reload fuel using ENC WREM-II Model.** Cooke, G.C. (Exxon Nuclear Co., Inc., Richland, Wash. (USA)). 7 Feb 1978. 35p. Nuclear Co., Inc., Richland, WA.

Additional information on the analysis of fuel rod rupture pressure and flow blockage versus fuel rod exposure in the Cook-1 Reactor is presented. The result of application of the rupture pressure uncertainty analysis is provided for exposures from fuel beginning-of-life to fuel end-of-life (approximately 38,000 MWD/MTM peak pellet exposure). The results are such that beyond 20,000 MWD/MTM peak pellet exposure, the upper bound pressure lies beyond the point of minimum flow blockage (23%) and, hence, total peaking (F/sub Q//sup T/) must be reduced in order to maintain calculated peak clad temperature below 2200°F. Hence, the ECCS limit on F/sub Q//sup T/ has a constant value of 1.95 out to 20,000 MWD/MTM peak pellet burnup and then decreases linearly with burnup thereafter.

35269 **Safety evaluation of the SECURE nuclear district heating plant.** Bento, J.P. (AB Stomenergi, Nykoeping, Sweden); Mankamo, T. *Nucl. Technol.;* **38**: No. 1, 126-134(Apr 1978).

A new reactor concept, SECURE (Safe and Environmentally Clean Urban REactor), has been developed in a joint Finnish-Swedish design project. This is a low temperature reactor intended for district heating purposes. The goal has been to design a reactor where the safety is based on built-in properties and to minimize dependence on engineered safety systems or operator action following abnormal occurrences. Choosing a pool reactor concept and placing the reactor in an underground rock cavern result in many safety advantages. Parallel to the design work a safety review was carried out including the assessment of plant system reliability and identification of potential accident sequences. Environmental consequences due to both normal operation and even unlikely accidents were calculated to be minor. The proposed plant concept is assessed to result in a safety level that should make the siting of the plant near urban centers possible with minimal risks.

35270 **Risk assessment of urban-sited heating reactors.** Savolainen, I.; Tarjanne, R.; Vuori, S. (Technical Research Centre of Finland, Helsinki). *Nucl. Technol.;* **38**: No. 1, 135-143(Apr 1978).

Small single-purpose heating reactors [100 to 400 MW(thermal)] for district heat production would be economically feasible if the could be sited in the immediate vicinity of heat consumption areas. This close urban siting requires that the reactor plant be designed with an objective to make the most severe accidents extremely improbable. When this aim is assumed to be fulfilled, the probability of acute health effects will be insignificant. The expectation values of the potential delayed health effects caused by

the collective doses brought about by accidents or norm operation will be very low as well, and will be clearly smaller than the excess mortality due to the other alternatives for district heat production.

35271 Boiling water reactor scram reactivity characteristics. Cheng, H.S.; Diamond, D.J.; Lu, M.S. (Brookhaven National Lab., Upton, NY). *Nucl. Technol.;* **37**: No. 3, 246-260(Mar 1978).

An extensive study of boiling water reactor scram reactivity behavior is presented. It is based on a spacetime analysis using a two-dimensional (R,Z) dynamics code that includes a two-phase thermal-hydraulics model. Calculations were made of the sensitivity of scram to such physical quantities as initial control rod position and power distribution, scram speed, system pressure, and varying inlet flow rate and temperature. The end-of-cycle Haling operating condition with all rods initially withdrawn was found to give rise to the limiting scram reactivity function. Calculations were also made to find the effect on scram of commonly used modeling approximations. These included the effect of neglecting delayed neutrons (conservative), using a time invariant void distribution (nonconservative), and defining point kinetics parameters in terms of different weighting functions. The importance of defining these parameters consistent with their use in plant transient analyses was also demonstrated.

35272 Experimental studies of the growth of an internally heated liquid pool in a solid bed. Farhadieh, R.; Baker, L. Jr. (Argonne National Lab., IL). *Nucl. Sci. Eng.;* **65**: No. 2, 394-400(Feb 1978).

Two-dimensional simulation experiments have been conducted on the growth of an internally heated liquid pool in a solid bed. The solid bed is a water-soluble wax, whereas the liquid pool is an electrolyte solution. The liquid pool and the molten solid are mutually miscible. The initial density of the liquid pool is greater than that of the solid at the melting point. The growth characteristics of the hot liquid pool in the solid are affected by the initial density, viscosity, and internal heat generation. The size of the liquid pool is affected only by power density.

35273 Probabilistic analysis of liquid-metal fast breeder reactor accident consequences with response surface techniques. Vaurio, J.K.; Mueller, C. (Argonne National Lab., IL). *Nucl. Sci. Eng.;* **65**: No. 2, 401-413(Feb 1978).

Response surface techniques are presented for obtaining the probability distributions of selected consequences of a liquid-metal fast breeder reactor hypothetical core disruptive accident. The uncertainties of the consequences are considered as a variability of the system and model input parameters used in the accident analysis. Probability distributions are assigned to the input parameters, and parameter values are systematically chosen from these distributions. These input parameters are then used in deterministic consequence analyses that are performed by fast-running analogs of the comprehensive mechanistic accident analysis codes. The results of these deterministic consequence analyses are used to generate the coefficients for response surface functions that approximate the consequences in terms of the selected input parameters. These approximating functions are then used to generate the probability distributions of the consequences with random sampling being used to obtain values for the accident parameters from their distributions. Two different schemes are presented for selecting the knot-point values of the input parameters. The first generates a single second-order polynomial for the entire parameter space; the second generates separate polynomials for specified regions of the parameter space. The calculation of conditional distributions of the consequences and the use of these distributions to define importance distributions of the input parameters are presented. The use of these procedures is illustrated by applications to a postulated loss-of-flow transient with failure to scram in a Clinch River Breeder-type reactor.

35274 Uniform risk functionals for characterization of strong earthquake ground motions. Anderson, J.G.; Trifunac, M.D. (Univ. of Southern California, Los Angeles). *Bull. Seismol. Soc. Am.;* **68**: No. 1, 205-218(Feb 1978).

A uniform risk functional (e.g., Fourier spectrum, response spectrum, duration, etc.) is defined so that the probability that it is exceeded by some earthquake during a selected period of time is independent of the frequency of seismic waves. Such a functional is derived by an independent calculation, at each frequency, for the probability that the quantity being considered will be exceeded. Different aspects of the seismicity can control the amplitude of a uniform risk functional in different frequency ranges, and a uniform risk functional does not necessarily describe the strong shaking from any single earthquake. To be useful for calculating uniform risk functionals, a scaling relationship must provide an independent estimate of amplitudes of the functional in several frequency bands. The scaling relationship of Trifunac (1976) for Fourier spectra satisfies this requirement and further describes the distribution of spectral amplitudes about the mean trend; here, it is applied to find uniform risk Fourier amplitude spectra. In an application to finding the uniform risk spectra at a realistic site, this method is quite sensitive to the description of seismicity. Distinct models of seismicity, all consistent with our current level of knowledge of an area, can give significantly different risk estimates.

35275 Trends in power industry and the safety of nuclear power plants. Adam, E. (Technische Univ., Dresden (German Democratic Republic). Sektion Energieumwandlung). *Kernenergie;* **21**: No. 1, 1-7(Jan 1978). (In German).

In many countries evolution in the field of fossil raw power sources tends to an increasing use of nuclear power in power economy. Future fields of nuclear power utilization and trends in reactor engineering development are discussed and evaluated. The increasing total potential of nuclear power plants and, consequently, the noticeable accumulation of radioactive fission products as well as the demands for economic generation of electric power call for continuous improvement of our understanding of the emergency behaviour of nuclear reactors and of optimizing the safety techniques used. Starting from the current state of knowledge about loss-of-coolant accidents of the pressurized water reactor, results of studies concerned with some partial problems of this type of accident are given. Emphasis is put on stresses arising from the release of coolant from the pressure vessel and from possible destructions of parts of the core. The information obtained is verified by experimental studies.

35276 Void distribution in boiling pools with internal heat generation. Kazimi, M.S. (Massachusetts Inst. of Tech., Cambridge); Chen, J.C. *Nucl. Sci. Eng.;* **65**: No. 1, 17-27(Jan 1978).

An analytical and experimental investigation of void distribution in internally heated boiling pools is presented. The experimental investigation involved measurement of the vertical profile of the void fraction and the average void fraction in an aqueous solution of $ZnSO_4$. If the results of this investigation are extended to a boiling pool of UO_2, it is predicted that substantial voiding will occur even when only a very small fraction of nominal operating power density in nuclear reactors is consumed in internal vaporization.

35277 Space—time dynamics of a fast breeder reactor for localized disturbances. Doshi, J.B.; Grossman, L.M. (Univ. of California, Berkeley). *Nucl. Sci. Eng.;* **65**: No. 1, 106-129(Jan 1978).

A method of analysis is developed for nuclear reactor accident initiating events that are localized in space. The method is based on a flux factorization technique, accounting for the flux shape changes taking place near the region of perturbation. In the steady state, the neutron shape functions are expanded in a series of eigenfunctions of the steady-state group removal operator. During the unsteady state, the time-dependent group shape functions are expanded in a series of the same stationary eigenfunctions with time-dependent Fourier coefficients. An auxiliary function is added to this expansion to take account of the spatial variation of the spectral hardening of neutrons in the immediate vicinity of the disturbed region. From the resulting representation of the group shape functions, the equations to be satisfied by the time-dependent Fourier coefficients and the time-dependent auxiliary shape function due to the disturbed region are developed consistently. A typical large [1000-MW(e)] liquid-metal fast breeder reactor with two radial core zones of different enrichments is analyzed by the above method. The transient initiating perturbation is taken to be a specified rate of coolant voiding from a single subassembly in the reactor core. The results show a strong dependence of the reactivity added on the radial location of the voiding perturbation and on the rate of voiding.

35278 Probabilistic analysis of the interfacing system loss-of-coolant accident and implications on design decisions. Leverenz, F.L. Jr.; Garcia, A.A.; Kelly, J.E. (Science Applications, Inc., Palo Alto, CA). *Nucl. Technol.;* **37**: No. 1, 5-12(Jan 1978).

One of the important findings of the Reactor Safety Study (RSS) was the identification of the risk due to an interfacing system loss-of-coolant accident (LOCA), i.e., failure of interfaces between the high-pressure primary system and the low-pressure injection system (LPIS). Because equivalent interfaces exist in all pressurized water reactors (although not necessarily with the LPIS), the U.S. Nuclear Regulatory Commission (NRC) has included in its Standard Review Plan three equally acceptable designs intended to decrease the risk due to potential interface failures by decreasing the probability of an interfacing system LOCA. The present analysis of the RSS system configuration is in general agreement with the RSS results; however, the RSS presented a linearized estimate of the exact result, such that the probability of occurrence is overestimated from 0 to 5 yr of plant life and underestimated for plant life beyond 5 yr. In addition, this analysis shows that the NRC design options are not probabilistically equivalent; probabilistically, these options vary by four orders of magnitude, and one option could be implemented in such a way as to yield a probability of occurrence greater than the RSS evaluated design. Finally, as a demonstration of the power inherent in the probabilistic methods, the analysis itself reveals the dominate system failure (gross check valve leaks) leading to a limiting design that eliminates this failure mode and reduces the probability to an insignificant level.

35279 Use of the method of characteristics for examination of two-phase flow behavior. Tentner, A.; Weisman, J. (Univ. of Cincinnati). *Nucl. Technol.;* **37**: No. 1, 19-28(Jan 1978).

The effect of unequal vapor and liquid velocities has been introduced into the conservation equations in a manner that is consistent with the use of the method of characteristics. It is shown that these reformulated equations have real characteristics if realistic slip ratios are used. The low slip ratios needed to ensure real characteristics at high mass flow rates are in conformity with the view that the slip ratio must approach 1.0 at these conditions. Application of the computational procedure to the estimation of critical flow rates leads to predictions in agreement with the homogeneous-equilibrium model when thermodynamic equilibrium is assumed.

35280 Dealing with uncertainty in fuel rod modeling. Oldberg, S. Jr. (Electric Power Research Inst., Palo Alto, CA); Christensen, R.A. *Nucl. Technol.;* **37**: No. 1, 40-47(Jan 1978).

A review of the characteristics of available fuel rod reliability models reveals an extremely wide range of opinion regarding the scale of complexity appropriate to the problem. It is argued that this diversity of opinion is symptomatic of a model building style in which no attention is formally paid to the uncertainty in the model predictions. An information-theory-based methodology is suggested as a means for systematically building a model in which the information content of the prediction is no more and no less than the information content of the supporting data.

35281 Failed fuel pin performance in fast metal-cooled reactors. Plitz, H. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). *Nucl. Technol.;* **37**: No. 1, 48-58(Jan 1978).

Experience with continued operation of failed mixed-oxide fuel pins in liquid-metal-cooled reactors or in-pile sodium loops is available from a variety of beyond-fuel-failure experiments. The phenomena and effects on a large reactor system of continued beyond-fuel-failure operation are not well understood, but, except for the release and deposition of fission products and the chemical reaction of sodium coolant to oxide fuel, leading to pin swelling, no failure propagation due to continued operation of failed fuel pins has been observed. For economic reactor operation, further investigations are needed to establish a catalog of fuel failure types, sizes, and locations to describe the time-dependent effects of continued operation on reactor operation, shutdown requirements, instrumentation, surveillance, circuit systems, contamination, maintenance systems, and plant efficiency.

35282 Accidents with atomic power structures. Bean, C. *Inf. Aeraul. Therm.;* **23**: No. 12, 8-10(Dec 1977).

The radiation hazards caused by accidents with atomic power structures, and the public relations aspects of any such accidents, are discussed. Undue secrecy in handling information about incidents that have occurred is deprecated. In particular, safety problems and policies in relation to the United Kingdom nuclear power programme, and the use of radioisotopes, are considered.

35283 Structure shielding in reactor accidents. Burson, Z.G. (EG and G, Inc., Santa Barbara, Calif. (USA)); Profio, A.E. *Health Phys.;* **33**: No. 4, 287-299(Oct 1977).

Radiation shielding provided by transportation vehicles and structures typical of where people live and work were estimated for cloud and fallout gamma-ray sources resulting from a hypothetical reactor accident. Dose reduction factors are recommended for a variety of situations for realistically assessing the consequences of reactor accidents.

35284 Certain aspects of the shutdown of nuclear power plants. Brosche, D.; Essmann, J. (Bayernwerk, Munich, Ger). *VGB Kraftwerkstech.;* **57**: No. 9, 598-603(Sep 1977). (In German).

The need to develop a satisfactory concept of radiation protection during nuclear reactor shutdown operations, including the disposal of radioactive components, is stressed. A number of methods of achieving either partial or total removal of radioactive components are described. The experience acquired in the shutdown of a number of nuclear reactors in the United States and Europe is summarized. 7 refs.

35285 Multielement model for design investigation of breakdowns with heat carrier loss at nuclear power plants. Bukrinskii, A.M.; Fuks, R.L. (All-Union Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 7, 77-81(Jul 1977). (In Russian).

The proposed mathematical model is a step forward in the development of mathematical modeling of breakdowns with heat carrier loss, compared with the Soviet model TECH6-12 in which the first loop is represented by 12 interconnected elements with thermodynamic parameters averaged within the limits of each element. The new model is envisaged for the calculation of the parameters used as initial data in designing individual channels of the active zone and parameters under the shell according to special programs. The program realized in ALGOL-60 and FORTRAN-IV languages for the BESM-6 computer permits investigation of different consequences of breakdowns with the loss of heat carrier. The program is based on a flexible structural model, thus permitting consideration of any number of elements and their arbitrary layout. This is achieved by introducing topological data into the computer memory. Each element and route gets its ordinal number. 11 refs.

35286 Experimental study on PWR-LOCA by ROSA-II. II. Effect of cold-leg injection of LPCI. Shiba, M.; Adachi, H.; Okazaki, M.; Sobajima, M.; Suzuki, M. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). *Nippon Genshiryoku Gakkaishi;* **19**: No. 6, 408-419(Jun 1977). (In Japanese).

Behavior of water injected into cold-leg piping by accumulator system and low pressure coolant injection system and the effect of the coolant injection on core cooling are discussed for the case of large double-ended cold-leg break. Major results are as follows: (1) Steam-water counter-current two-phase flow in downcomer limits downcomer penetration rate of the injected water and results in longer duration of refill phase. Enlarging downcomer gap is effective for increasing the penetration rate. (2) Steam binding due to high core temperature interferes with coolant entering into the core and the resultant core cooling. Chugging oscillation occurs while mixture level rises in the active core region. (3) It is of considerable importance to note that in order to achieve effective core cooling during the long reflooding process, mixture level must be raised to the active core region before the core temperature becomes very high.

35287 Evaluation of effects of finite mixing time and non-condensable gas on fuel sodium interactions. Saito, S. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). *J. Nucl. Sci. Technol. (Tokyo);* **14**: No. 6, 395-406(Jun 1977).

An approach has been tried to provide more realistic estimates of pressure history and mechanical work caused by fuel-sodium interaction (FSI) in postulated fast reactor accident. The work reported here is specifically focussed on the evaluation of the effects due to fragmentation process or finite mixing time and presence of non-condensable gas on FSI. As one of the methods to describe the fragmentation process in FSI, the mass of fuel which interacts with sodium has been introduced as a function of time. The presence of non-condensable gas in the unheated sodium regions above and below the interaction region as well as in the interaction region itself has been taken into account in the model, which affects value of sonic velocity in the former, and volume change in the latter. An extensive parametric study has led the conclusion that the total mechanical work as well as a value of peak pressure at the initial period in which sodium remains liquid strongly decrease with the mixing time constants and/or non-condensable gas content in the system, and in the most plausible case, a possible maximum value of peak pressure through the entire period in the fuel-sodium interaction appears to be at most a few hundred atmospheres.

35288 (AAEC-LIB/Trans—623) Diffusion of iodine in water: the Piree experiment. Dadillon, J.; Geisse, G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Mar 1977. Translated from CEA-R-3199. 22p.p. Dep. NTIS (US Sales Only), PC A02/MF A01.

This experiment is part of a general program of water cooled reactor safety studies. The experiment is carried out at almost full scale, out-of-pile. At the bottom of a $45m^3$ tank filled with demineralised water, carbon dioxide gas contaminated with radioactive iodine is injected at a pressure of 20 bars (2 MPa) and a temperature of 400^0C. Under these conditions only about 0.1% of the iodine reaches the water surface and is released to the air. However, exchange conditions between water and air cause a further release of iodine, which is proportional to time.

35289 Nuclear energy and public opinion: arousal of a myth. Agrafiotis, D.; Delarminat, E.; Morlat, G.; Pages, J.P. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Protection). pp 1375-1380 of Proceedings of the 4. International congress of the International Radiation Protection Association. Paris, 24-30 April 1977. Vol. 4. Fontenay-aux-Roses, France; Association Internationale de Protection contre les Rayonnements (1977). (In French)

From 4. congress of the International Radiation Protection Agency; Paris, France (24 Apr 1977).

See CONF-770409—. Available from M. Gilbert Bresson, General Secretary IRPA, B.P. No. 33, 92260 Fontenay-aux-Roses, France.

In order to explain why an individual or the public opinion is in favour or against the peaceful uses of nuclear energy, one should not only consider the dimension of the involved risk, as radiation protection and safety experts will often do. Many other dimensions should be considered all the more as the nuclear problem is gaining importance on a national level, becoming the topic of the day in press and other media and the subject of 'definite' position from political parties and social groups. An investigation carried out within the Protection Division of the French Atomic Energy Com-

mission (C.E.A.) has made it possible to specify the socio-cultural dimensions at the origin of the attitudes taken on the nuclear problem in France. The nuclear topic was therefore compared with other present topics interesting public opinion; this comparison was made possible by means of an attitude survey covering various social groups. A model of social perception was thus developed.

35290 Technical safety. A comparison of risks. Lingen, P. (Farbenfabriken Bayer A.G., Leverkusen (Germany, F.R.)). *Schmierungstechnik;* 6: No. 1, 3-11(1977). (In German).

Technical risks are compared to the publically consciously or unconsciously accepted risks. This kind of risk analysis has the aim to achieve an optimum safety with a justifiable effort. The realization of this target requires the solving of technical, economic and socio-political problems. In order to minimize the risk, one can reduce the probability of occurence as well as the extent of damage. Risk situations for the population due to natural occurences such as earthquakes, strike of lightning, frost, high water etc. can be relatively well quantified. These are therefore suitable a a basis for comparison. This basis risk is increased by individual traffic and by human force effects such as terror and war. On the other hand, life in the neighbourhood of a nuclear power plant does not measurably contribute to increasing individual risk. In principle, by increased expenditure one can reduce technical risks. Due to the lack of means, one must then save correspondingly somewhere else. The safety risks there can then possibly increase overproportionally or at least the wide-spread desire for a higher standard of living cannot be fulfilled. Nevertheless, absolute safety can never be reached. The insurance business is responsible for covering the financial damage. Fault trees are used in technology to analyse the weak points. This is explained taking the example of a propylene low-temperature tank. If one keeps below the base risk it must be possible to build technical plants, even nuclear power plants, in densely populated areas. Technical safety analyses, however, only embrace one side of it, rigid building and material control and extensive elimination of human error are just as important.

35291 Computer methods for fluid-structure interaction problems. New York; American Society of Mechanical Engineers (1977). 15-34p.

From Conference on computer methods for fluid-structure interaction problems; Atlanta, GA, USA (27 Nov 1977).

Sudden loss of coolant in a pressurized water reactor due to failure of a coolant pipe would result in flashing of the coolant accompanied by the propagation of a rarefaction wave into the downcomer. The paper discusses a computer program that simultaneously calculates the behavior of the coolant and the accompanying motion of the core support barrel, which is considered as a three-dimensional shell with both membrane and bending stresses. 15 refs.

35292 Non-linear lateral mechanical response of pressurized water reactor fuel assemblies. Grubb, R.L.; Saffell, B.F. Jr. (EGandG Idaho, Inc, Idaho Falls). *Am. Soc. Mech. Eng., [Pap.];* No. 77-WA/DE-18, 1-8(1977).

Mechanical response analysis of 15 adjacent fuel assemblies subjected to postulated loss-of-coolant accident (LOCA) loadings is described in this paper. A structural and mass model is developed for each fuel assembly. The gaps between adjacent fuel assemblies and between the fuel and baffle plates are included in the structural representation. Spacer grid impact forces are defined within these gap elements by springs which become active when contact is made between adjacent grids. Core plates located at the top and bottom of the core couple the fuel assemblies together. Transient plate motions, as obtained from a primary coolant system dynamic analysis, are used as the system forcing function. Mechanical responses of the fuel assemblies including spacer grid impact forces are defined using a modified modal analysis technique. 3 refs.

35293 Dynamic analysis of a pressurized water reactor primary coolant system subjected to postulated loss-of-coolant accident transient loads. Mathews, R.E.; Saffell, B.F. Jr.; Mattu, R.F. (EGandG Idaho, Inc, Idaho Falls). *Am. Soc. Mech. Eng., [Pap.];* No. 77-WA/DE-23, 1-8(1977).

An independent, time history, dynamic analysis of a three-loop pressurized water reactor (PWR) has been performed for a postulated rupture of the cold leg primary coolant piping at the reactor pressure vessel nozzle. This postulated, instantaneous (less than 0.020 sec) rupture of a reactor system primary coolant pipe is a loss-of-coolant accident (LOCA). Such an event causes large magnitude, short-duration mechanical loads on piping, components, and component supports. The structural response of the primary coolant system is defined by first formulating a finite element representation of the loop piping, major components in the piping loops, reactor vessel with internals, and the major component supports. The transient forcing functions which are utilized to excite the system are developed from plant hydraulic analyses. Specifically, subcooled blowdown piping loads and asymmetric loads on the core barrel are applied simultaneously with the cavity pressure loads on the reactor vessel. Reactor pressure vessel (RPV) support loads are among the parameters obtained from the transient response analysis. The structural model, source and application of transient forces, and the computer code utilized for the mechanical response analysis are described in this paper. Results of the analysis are provided in the form of peak RPV support loads. 4 refs.

35294 Seismic design for steam generators. Asmis, G.J.K. (AECL). pp 25-26 of Canadian Nuclear Association--annual international conference proceedings, 17, Volumes 1 through 6, 1977. Montreal; Canadian Nuclear Association (1977).

From 17. annual international conference of the Canadian Nuclear Association; Montreal, Ontario, Canada (5 Jun 1977).

This extended abstract reviews various methods of seismic analysis of steam generators and concludes that a coupled building/steam generator analysis, carried out on only one system, with the weight of the remaining three systems lumped into the building structure, would provide conservative but reasonable results; whereas, an analysis modelling all four systems would not only lead to a more extensive and complicated analysis but would also underestimate the response. 2 refs.

35295 Facility for qualification testing of equipment in post LOCA environments. Stern, F.; Hayes, R.C. (Westinghouse Can Ltd). pp 42-44 of Canadian Nuclear Association--annual international conference proceedings, 17, Volumes 1 through 6, 1977. Montreal; Canadian Nuclear Association (1977).

From 17. annual international conference of the Canadian Nuclear Association; Montreal, Ontario, Canada (5 Jun 1977).

This extended abstract describes a facility to test the adequacy of equipment design under normal, abnormal, LOCA and post-LOCA containment conditions. This facility permits qualification of many types of equipment including vertical or horizontal containment cooling fans, emergency cooling pumps, hydrogen recombiner systems, electric motors, instrument devices and so on, with or without the equipment operating at its design load. 2 refs.

35296 Confirmation of CANDU shut-down system design and performance during commissioning. Dastur, A.R.; Kugler, G.; Rouben, B.; Li, H.Y.H. (AECL). pp 77-79 of Canadian Nuclear Association--annual international conference proceedings, 17, Volumes 1 through 6, 1977. Montreal; Canadian Nuclear Association (1977).

From 17. annual internatonal conference of the Canadian Nuclear Association; Montreal, Ontario, Canada (5 Jun 1977).

To CANDU reactors the shutdown system design and safety analysis are appreciably influenced by neutronic decoupling of reactor segments, delayed neutron holdback, and asymmetric insertion of reactivity devices. Tests carried out during the commissioning phase of the first two units of the Bruce power plant have confirmed the shutdown system reliability and the predicted magnitude of the above effects. This extended abstract discusses the dynamic and static tests and their mathematical confirmation. 4 refs.

35297 Effects of cracks on the seismic analysis of reinforced concrete nuclear containment vessels. Smith, J.K. Ithaca, NY; Cornell Univ. (1977). 173p. University Microfilms Order No. 78-01,672. Thesis (Ph. D.).

Reinforced concrete nuclear containment vessels would be cracked in both the horizontal and vertical directions by an internal pressurization caused by a loss of coolant accident in the reactor and steam supply system of a nuclear power plant. If an earthquake occurs simultaneously with the loss of coolant accident some means must be found to transfer the shear forces developed by the earthquake across the cracks. Current design codes imply that inclined reinforcement needs to be used in highly seismic areas to transfer these forces across the cracks. The inclined steel is expensive to form and decreases the quality of the concrete because of the congestion of steel reinforcing bars. The plausibility of an alternative design which utilizes the combination of dowel action of the longitudinal reinforcement and the shear transfer capacity of the horizontal cracks is studied. The results of tests performed to investigate the shear transfer characteristics of cracks are shown and discussed. These test results are used as input to a finite element model which was used to study the shear stress distribution at cracks. A computer program was developed which incorporated these experimental and analytical results into the seismic analysis of a cracked reinforced concrete containment vessel. A linear seismic analysis which yields results giving a least squares fit to the nonlinear results for the synthetic earthquake was developed. The main conclusion arrived at in this study is that the inclined reinforcing steel may be eliminated from the design of nuclear containment vessels. The shear transfer capability of the horizontal cracks can adequately resist the shear forces developed by the design earthquakes normally used in containment vessel design.

35298 Simulation of the cladding freezing during the loss of flow accident in gas-cooled fast breeder reactors. Chu, N.N.Y. Chicago; Northwestern Univ. (1977). 151p. University Microfilms Order No. 78-00,693.

Thesis (Ph. D.).

The accident condition of the stainless steel cladding melting, relocation and freezing, following a loss of flow situation in gas-cooled fast reactors has not been determined yet. The stainless steel cladding starts to melt from slightly below the core center and flows down into the lower blanket region. Due to locally low-power generation in blanket rods, heat is transferred from the liquid to the solid cladding which causes the molten cladding to freeze. To model this, an alloy of 50Pb/50Sn was selected to facilitate experimental procedures because of its workability and its wide phase transition temperature range (183 to 216°C) similar to that of stainless steel (1375 to 1500°C). The objective of the experiment is to simulate the motion of liquid alloy through a tube and observe the conditions where it solidifies in the tube. The objective of the theoretical model is to use transient heat transfer analysis to describe the freezing front of the moving liquid metal and the plugging of the channel.

35299 Depressurization accident analysis of VHTR. Matsuki, Y.; Tanaka, Y. (Kawasaki Heavy Industries Ltd., Kobe (Japan)). *FAPIG (Tokyo);* No. 83, 2-7, 33(Nov 1976). (In Japanese).

The works to quantitatively evaluate the soundness of the compartment of a multi-purpose, high temperature gas, experimental reactor at the time of the accident were started when the basic concept design was entrusted to Kawasaki Heavy Industries Co., Ltd. For the analysis in this stage, the code GASRUP was used, but the result of the analysis underestimated the internal pressure rise in the compartment. In the first concept design, the new code COMPA was developed, and in the calculation model adopted, it was assumed that air and helium mix perfectly within the compartment. It was clarified afterwards that the perfect mix model was not necessarily satisfactory for the conservative evaluation of the internal pressure rise in the compartment. The analysis code system TACCS was developed by revising the code COMPA totally. It consists of three independently usable codes, STEDY for calculating the temperature distribution and the channel frictional coefficient in the steady state of the primary cooling system, TRANS for calculating the transient response of the primary cooling system at the time of pressure boundary breakage, and COMPA for calculating the transient internal pressure in the compartment and the containment vessel. The examples of the analysis with the TACCS code system and the improvement of the analysis codes for future are described.

35300 Studies for aseismatic design of atomic power equipment. Uchiyama, Y.; Takayanagi, M.; Moriyama, T.; Mizuno, S. (Hitachi Ltd., Tokyo (Japan)). *Hitachi Hyoron;* **58**: No. 10, 825-830(Oct 1976). (In Japanese).

The social requirements for the safety of nuclear power stations are very severe, and especially in Japan where earthquakes occur frequently, the safety against earthquakes is regarded as an important matter. The machinery and equipment composing nuclear power plants have largely different roles in the safety, accordingly it is important to maintain effectively the safety as a whole. The design is carried out by classifying buildings, machinery and equipments, pipings and electric appliances according to the importance, and so that the aseismatic property corresponding to the importance is given to each. In most cases, the aseismatic design is carried out with computing codes, but it is necessary to forward the design by proving the propriety of analysis models and calculated results. Efforts are exerted in Hitachi Ltd. to improve the accuracy of the aseismatic analysis by carrying out basic experiment, the demonstration test in actual plants and the study on analytical method as many as possible. The measurement of the vibration of actual pipings in order to confirm the supporting conditions, the comparison of multi-input analysis and SRSS method for piping analysis, and the vibration tests of a model containment vessel and a fuel assembly were carried out, and the results are reported in this paper. It is important to improve the accuracy of earthquake response analysis further.

ACCIDENT LIABILITY

35301 (INIS-mf—3902) **Present state of nuclear power plants insurance in Belgium.** Lacroix, F. (American Nuclear Society, Mol (Belgium). Belgian Section). 1976. 13p. (In French). (CONF-7606173—2). Dep. NTIS (US Sales Only), PC A02/MF A01.

From Meeting of the Belgian section of the American Nuclear Society; Mol, Belgium (17 Jun 1976).

A brief recall is given of the main provisions of international conventions on civil liability in the scope of the nuclear energy and a description of the insurance conditions. The insurance problems of damages including the security of some special risks are considered.

ENERGY STORAGE

MAGNETIC

35302 (LA-UR—77-2805) **Use of superconductive technology for energy storage and power transmission for large power systems: power parks.** Keller, W.E. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 19p. (CONF-771130—2). Dep. NTIS, PC A02/MF A01.

From International scientific forum on an acceptable nuclear energy future of the world; Coral Gables, FL, USA (7 Nov 1977).

A general review and technology assessment of superconducting magnets for energy storage and superconducting cables for power transmission are presented. It is concluded that the technology is now available for applying superconductivity in the power industry. (TFD)

PUMPED HYDRO

35303 Technical problems specific to pump-turbine sets. Casacci, S.; Boussuges, P.; Amblard, H. (Soc Neyrpic, Fr). *Rev. Gen. Electr.;* **86**: No. 9, 672-679(Sep 1977). (In French).

After briefly recalling the different operating conditions, the rules for representing the transient motions in the four quadrants are specified and the vibrations that arise under these conditions as well as the pressure and torque fluctuations are considered. The problems relating to the construction of large pump-turbine sets concerning both the distributor and the wheel are discussed. Finally, the prospects of evolution of these machines, characterized by the search for increasingly higher discharge heights and speeds for low heads and the increase of unit capacity, are evaluated.

35304 Production management of the Electricite de France pumped storage plants. Flahaut, P. (Electr de Fr). *Rev. Gen. Electr.;* **86**: No. 7-8, 582-587(Jul-Aug 1977). (In French).

After a brief description of the electric current consumption characteristics and of the use of the facilities, the article describes two operating procedures of the pumping stations as well as the economical selections to which they lead, i.e., transfer of peak hours to off-peak hours, and constitution of a storage. To conclude, some information is given on the equipment in operation or currently under construction and an increasing role is forecast for the pumping works in connection with the advent of nuclear power plants.

35305 Operation of the Coo-Trois Ponts pumped storage plant by the national distribution center of Belgium. Gaumier, L.; Seydel, J. (Soc pour la Coord de la Prod et du Transp de l'Energ Electr, Rhode-St-Genese, Belg). *Rev. Gen. Electr.;* **86**: No. 7-8, 592-596(Jul-Aug 1977). (In French).

After a brief description of the Coo-Trois Ponts power station and of its aims, the article describes on the one hand, the organization of electric power production in Belgium and, on the other hand, the incorporation of the pumping station in this production. The typical operating diagram, the operating economy and the non-availability as well as the operating life of the station are considered. To conclude, due to the operating results wich have been recorded with the first phase, another plant which is to be shortly erected is briefly mentioned.

35306 In-service operating tests of the pumped-turbine-set of Vouglans. Cabrol, J. (Electr de Fr). *Rev. Gen. Electr.;* **86**: No. 7-8, 597-604(Jul-Aug 1977). (In French).

After a brief recall of the characteristics and starting procedures of the pump-turbine-set No. 4, at Vouglans, the article describes the complete tests which have been carried out with the turbine-pump-set and with the corresponding motor-generator set, in regular operation as well as on start. To conclude the practical operation of this reversible set is summed up.

35307 Control of the reactive power of hydroelectric units operating as pumps for energy storage. Gasparini, E. (Ente Naz per l'Energ Elettr, Venezia, Italy). *Energ. Elettr.;* **54**: No. 7/8, 373-375(1977). (In Italian).

The excitation systems for synchronous machines equipped with a quick reactive power control which is obtained by adding a proportional feedback to the reference voltage are described. During the operation of the unit as a pump the feedback ratio is selected at a rather high value according to the criterion which is described, in order to minimize the stator current, to prevent overloads, to limit transmission losses and to restrain terminal voltage variations. The way to control reactive power is only one, both in generating and in pumping operation. So it is easy to apply a generalized system for distribution and secondary governing of reactive power.

FLYWHEELS

REFER ALSO TO CITATION(S) 35511

THERMAL

35308 (ORO—5159-10) **Form-stable crystalline polymer pellets for thermal energy storage. Phase 1.** Botham, R.A.; Jenkins, G.H.; Ball, G.L. III; Salyer, I.O. (Monsanto Research Corp., Dayton, Ohio (USA)). Jul 1977. Contract EY-76-C-05-5159. 115p. Dep. NTIS, PC A06/MF A01.

The objective of this project was to develop a form-stable, crystalline polymer pellet TES bed material, useful in the 120 to 140°C temperature range suitable for solar absorption air conditioning applications. This objective was achieved with a Si-O-Si crosslinked HDPE pellet material, demonstrated to have a high heat of fusion value (46 cal/g, approximately 98% of the HDPE's heat of fusion value prior to crosslinking). Further, on melt/freeze cycling of these TES pellets through 400 cycles in ethylene glycol, they retained nearly 100% of their initial heat of fusion value, and had excellent form-stability characteristics, with little or no inter-particle adhesion. Appropriate testing of this TES pellet material, from analytical (DSC) to a one gallon lab-scale TES unit, and finally to a 60 gallon prototype TES demonstration unit, consistently verified these results. C-C crosslinked PE products, which were slightly inferior to the Si-O-Si crosslinked PE in terms of good heat of fusion and form-stability properties, were also developed and are potential alternatives to the prime PE TES product.

35309 **Method of testing for rating thermal storage devices based on thermal performance.** Hill, J.E.; Kelly, G.E.; Peavy, B.A. (NBS, Washington, DC). *Sol. Energy;* **19**: No. 6, 721-732(1977).

This paper describes a proposed test method for determining the "effective capacity" and heat loss characteristics of thermal storage devices. The prescribed series of tests should provide useful data for the rating of thermal storage devices based on thermal performance. The apparatuses and major components used in the tests have been prescribed so a liquid or air can be used as the transfer fluid. The series of tests to be conducted consist of one steady-state test to determine the "effective capacity" for both heat storage and heat removal. During the transient tests, the entering fluid temperature is changed in a step-wise manner and amount of energy either stored or removed over a specified test time is determined. Sample experimental data are given to demonstrate the concept of the transient tests. 41 refs.

35310 **Production of hydrogen from methane by nuclear heat and the transmission of chemically bound heat in a closed loop cycle.** Ossami, S. (Univ. of Azarabadegan, Tabriz, Iran). pp 8p, Paper 6B5 of Hydrogen in metals. Vol. 10. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P10.

A closed loop reversible chemical system for transmission and storage of nuclear heat based on the production of hydrogen in a methane cycle is described. 95% of the methane is recycled. The thermal aspects of large scale methanation are discussed in detail using experimental results.

CHEMICAL

REFER ALSO TO CITATION(S) 34910

BATTERIES

35311 (CONF-7604144—) **Battery Council International convention, 1976.** (Battery Council International, Chicago, Ill. (USA)). 1976. 117p. Dep. NTIS (US Sales Only), PC A06/MF A01.

From Battery Council International convention; Mexico City, Mexico (27 Apr 1976).

Separate abstracts were prepared for eighteen of the items in these proceedings. Interspersed with these were nontechnical presentations dealing with the business of the society. (RWR)

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 35766

35312 (CONF-7604144—, pp 4-7) **International standard for industrial batteries: a European view.** Greening, L.C.; Budin, F. 1976.

From Battery Council International convention; Mexico City, Mexico (27 Apr 1976).

In Battery Council International convention, 1976.

Views on the desirability of standards for batteries for motive power are expressed. The market situation and potential for increased sales for forklift trucks, road delivery vehicles, and urban buses are examined. Organizations involved in coordinating standards are described. It is recommended that the benefits of standards be recognized, and their international adoption is encouraged. 1 table. (RWR)

35313 (CONF-7604144—, pp 8-13) **Charging forward: industry forecast market analysis, 1976—1980.** Burkard, R.A. (Globe Union, Milwaukee). 1976.

From Battery Council International convention; Mexico City, Mexico (27 Apr 1976).

In Battery Council International convention, 1976.

The battery market for several years preceding 1976 is discussed. Some projections are made through 1980. 2 figures, 18 tables. (RWR)

35314 (CONF-7604144—, pp 31-38) **Sodium—sulphur battery for motive power.** Halliwell, B. 1976.

From Battery Council International convention; Mexico City, Mexico (27 Apr 1976).

In Battery Council International convention, 1976.

Examples of battery-powered vehicles are given. The requirements for an acceptable vehicle battery are given; the lead—acid battery falls short, but the sodium/sulfur shows promise. The Na/S battery has liquid electrodes separated by a solid electrolyte, and operates around 300°C. The electrochemistry of this cell is explained, along with manufacturing procedures. Development targets and markets are discussed. Na/S will have little impact in the short term, and will likely not improve the market acceptability of electric cars. In conclusion, the present state of the art is reviewed. 25 figures. (RWR)

35315 (CONF-7604144—, pp 39-48) **Electrical rechargeable iron—air batteries: a way to the electrotraction.** Cnobloch, H. (Siemens Research Labs., Erlangen, Ger.). 1976.

From Battery Council International convention; Mexico City, Mexico (27 Apr 1976).

In Battery Council International convention, 1976.

Requirements of an electrically driven urban vehicle are analyzed first. Various types of batteries are contrasted, and then the Fe/air battery is discussed in some detail; electrode structure and performance of completed batteries are considered. Application of these batteries in vehicles is addressed; it is concluded that the best arrangement consists of a lead battery for starting and an Fe/air battery for distance. 25 figures. (RWR)

35316 (CONF-7604144—, pp 54-56) **Smelting of unbroken batteries and effect on the environment.** Bergsoe, S. (Paul Bergsoe and Son A/S, Glostrup, Denmark). 1976.

From Battery Council International convention; Mexico City, Mexico (27 Apr 1976).

In Battery Council International convention, 1976.

A description is given of processes and equipment developed in Scandinavia to deal with old batteries without producing health hazards either inside or outside the factory. Methods formerly used are reviewed first. The basic principle of the new method is to smelt the entire battery, case included. In addition, all raw materials are centralized in one closed building with water sprays to keep materials wet. The furnace and its operation are discussed at some length. Noise pollution is also kept to a minimum. (RWR)

35317 (CONF-7604144—, pp 72-75) **Lead—acid batteries for utility application.** Birk, J.R. 1976.

From Battery Council International convention; Mexico City, Mexico (27 Apr 1976).

In Battery Council International convention, 1976.

A U.S. market big enough to double the U.S. sales of secondary batteries exists in the electric utility industry. Leveling out the load on generating equipment with energy storage in order to place greater reliance on domestic fuels represents a major need of the U.S. utility industry and of the U.S. Batteries are the favorite bulk energy storage technology and, as a result, are enjoying a 1976 R and D commitment of over $10 million by the U.S. utilities and government—more money than being devoted to all other energy storage technologies combined. The reasons for the interest in battery energy storage, the expectations of the utility industry for batteries, and the prospects for lead—acid batteries to achieve these expectations are explored. 1 figure, 6 tables.

35318 (CONF-7604144—, pp 77-79) **Alkaline lead batteries.** Lindstrom. (Royal Inst. of Tech., Stockholm). 1976.

From Battery Council International convention; Mexico City, Mexico (27 Apr 1976).

In Battery Council International convention, 1976.

Development of an alkaline lead battery is discussed. The emphasis is on producing a battery with low first cost—then lifetime need not be so high. Cost per kAh is given for several electrode materials, such as lead, nickel, oxygen, and zinc. Results on performance of a Pb/Fe battery are sketched. (RWR)

35319 (CONF-7604144—, pp 79-82) **Air—water standards report.** Bitler, J. 1976.

From Battery Council International convention; Mexico City, Mexico (27 Apr 1976).

In Battery Council International convention, 1976.

Discharges of air and water outside the battery plant are considered. The discussion is limited to lead content. Applicable regulations are addressed, and some advice in meeting them is offered. A lime treatment system installed at a secondary smelter is described. 2 figures, 1 table. (RWR)

35320 (CONF-7604144—, pp 96-97) **Closed system.** Roper, J.W. (NL Industries, New York). 1976.

From Battery Council International convention; Mexico City, Mexico (27 Apr 1976).

In Battery Council International convention, 1976.

The operation of a closed system to handle, store, treat, and convey feed materials to the furnaces of a secondary lead smelter is described. The feed materials are whole scrap batteries, customer-generated residues, by-product drosses, and flue dust from plant operations. This feed material beneficiation plant is primarily designed to separate the metallic portion of the feed material from the oxide portion. This system is designed to meet all environmental regulations. (RWR)

PERFORMANCE AND TESTING

35321 (BNWL-tr—293) **Contribution to the mathematical description of electrochemical processes in the lead accumulator.** Lehning, H. Translated from *Elektrotech. Z., A;* **93**: No. 2, 62-66(1972). 22p. Dep. NTIS, PC A02/MF A01.

Detailed examination of the reactions and equilibration processes in the lead accumulator yielded differential equations which can be evaluated to simulate the discharge of a battery. However, the description is more qualitative, because it was impossible quantitatively to allow for perturbing influences such as pore deactivation, cross section contractions, and volume changes, as well as acid transport due to convection and the proportion of acid in the plate space. Continuous and intermittent discharges are discussed. Finally, an attempt is made to estimate the usable capacity of an accumulator as a function of the discharge current. This study suggests that the optimum discharge behavior can be expected with a thin-plate accumulator.

35322 (CONF-7604144—, pp 49-53) **Presentation at the 88th convention of Battery Council International, April 25—29, 1976.** Falk, U. (Nife Jungner AB, Oskarshamn, Sweden). 1976.

From Battery Council International convention; Mexico City, Mexico (27 Apr 1976).

In Battery Council International convention, 1976.

Electric batteries (particularly alkaline Ni/Cd) and the development philosophy behind them are considered, and the performance of Ni/Cd batteries is compared with that of lead—acid. The design of a pocket plate Ni/Cd battery is described, and a number of uses are listed. Construction and performance of cylindrical sealed Ni/Cd cells are treated more briefly; similar remarks are made about lead—acid batteries. (RWR)

35323 (CONF-7604144—, pp 57-63) **Battery warranties and product safety.** Schreiner, W. 1976.

From Battery Council International convention; Mexico City, Mexico (27 Apr 1976).

In Battery Council International convention, 1976.

Government regulations and legislation having to do with batteries and battery safety are briefly discussed. These regulations relate to safety standards, uniform performance standards, product safety, and notification of defects. The Warranty Act—in particular, the sections dealing with disclosure of written consumer product warranty terms and conditions and presale availability of written warranty terms—is considered. A panel discussion on product liability was held. Failure to warn of a potential hazard makes the product defective, and it is the responsibility of the battery manufacturer to provide proper warnings. (RWR)

35324 (CONF-7604144—, pp 86-88) **Maintenance free batteries.** Nicholas, H. (Varta Batterie AG, Hanover). 1976.

From Battery Council International convention; Mexico City, Mexico (27 Apr 1976).

In Battery Council International convention, 1976.

Field tests of maintenance-free batteries are discussed. Water decomposition and loss (to which self-discharge contributes significantly) are an important consideration; these batteries show marked improvement over conventional ones in this regard. Length of service was also studied; the median was 50 months. It is concluded from field experience that maintenance-free batteries have a service life at least equal to that of normal batteries. The service lives of normal batteries of different internal parameters from several companies were essentially the same; battery life is governed mainly by external parameters, dependent on either time or mileage. (RWR)

35325 (CONF-7604144—, pp 92-95) **Energy conservation, R and D and the lead—acid battery.** Cook, A.R. (International Lead Zinc Research Organization, Inc., New York). 1976.

From Battery Council International convention; Mexico City, Mexico (27 Apr 1976).

In Battery Council International convention, 1976.

The "energy crisis" is viewed from the perspective of an R and D man involved with batteries. Lead—acid batteries will find application in load leveling and electric vehicles; the challenge is to produce batteries capable of 2,500 deep discharge cycles. Batteries showing promise for the future include Zn/Cl_2, Na/S, Li/sulfide, and $Na/SbCl_3$. Only the lead—acid battery is presently available for on-the-road vehicles or storage of energy from solar-cell arrays (track circuits, signaling, etc.). But costs of solar cells must be reduced by a factor of 50. Research on lead—acid battery plates is recounted. Modified constant potential methods are best for charging at present; gas-controlled charging offers superior performance if sophisticated electronics is available. 1 figure. (RWR)

35326 **Techniques for the determination of ohmic drop in half-cells and full cells: a review.** Hayes, M.; Kuhn, A.T.; Patefield, W. (Univ of Salford, Engl). *J. Power Sources;* **2**: No. 2, 121-136(Dec 1977).

Different methods for the experimental determination of ohmic drop in batteries and half-cells are reviewed. The limitations in use of Luggin capillaries are defined. A novel method for elimination of ohmic error in high-resistance cells is described. This employs a programmable calculator or a minicomputer. By interpretation of the deviations from the log-rate law, values of internal resistance may be determined with some precision. A typical example is given and the results are compared with those obtained by classical oscillographic methods.

35327 **Thermal simulation of NiCd batteries for spacecraft.** Montalenti, P.; Stangerup, P. (Eur Space Technol Cent, Noordwijk, Neth). *J. Power Sources;* **2**: No. 2, 147-162(Dec 1977).

A study was made for the purpose of extending an earth satellite battery lifetime by minimizing the temperature differences between individual cells. NiCd cell and battery behavior was studied in typical spacecraft operating conditions, both theoretically and experimentally. The first stage of the study consisted in generating a model for the temperature distribution inside the cell for given heat generation values and confirming its validity through specific tests. The second stage consisted in predicting heat generation inside the cell in different operating conditions and checking prediction validity through testing. The third stage consisted in generating by network analysis a model of the thermal behavior of a full-scale battery in actual spacecraft operating conditions.

35328 **Current efficiency in the lithium—water battery.** Littauer, E.L.; Momyer, W.R.; Tsai, K.C. (Lockheed Palo Alto Res Lab, Calif). *J. Power Sources;* **2**: No. 2, 163-176(Dec 1977).

Under well-controlled conditions, the exceptional energy of the Li-H_2O reaction can be harnessed electrochemically with high Faradaic efficiency. The most important adjustable control parameters are electrolyte flow rate, electrolyte concentration, temperature and anode-cathode contact pressure. This paper describes a technique to diagnose the efficiency of individual cells or cell stacks via comparison of polarization curves and information on the open circuit corrosion rate of Li.

35329 **Experience in using bimodal distribution curves to evaluate the reliability of systems supplying energy from renewable sources.** Salieva, R.B. (Tashkent Electrotechnical Inst. of Communications). *Appl. Solar Energy (USSR) (Engl. Transl.);* **12**: No. 4, 43-47(1976).

Translated from Geliotekhnika; 12: No. 4, 57-62(1976).

Utilization of a bimodal curve to describe mathematically the distribution function W/sub phi/ for the duration of operation of an electric storage battery is considered. The parameter W/sub phi/ characterizes the distribution of the time of continuous functioning of the apparatus controlling electric storage battery operation. This is important: 90 to 95% of the energy demand is furnished by a wind- or solar-power unit in combined operation with an electric storage battery. 2 figures.

MATERIALS, COMPONENTS, AND AUXILIARIES

REFER ALSO TO CITATION(S) 35742

35330 (CONF-7604144—, pp 26-27) **Low cost charging indicator for SLI batteries.** Voss, E. (Varta Research Development Group, Kirkheim, Ger.). 1976.

From Battery Council International convention; Mexico City, Mexico (27 Apr 1976).

In Battery Council International convention, 1976.

The acid concentration in a lead—acid battery indicates its charge state, and any acid property dependent on concentration can be used for this purpose. A new type of indicator, based on the

reversible swelling of ion exchange membranes in H_2SO_4, is described. (RWR)

35331 (CONF-7604144—, pp 76-77) **Materials Committee report.** Kenny, R.J. 1976.

From Battery Council International convention; Mexico City, Mexico (27 Apr 1976).

In Battery Council International convention, 1976.

The supply and demand of lead and plastic—which account for 85 percent of the cost of a battery with a polypropylene case—are examined. Lead consumption and supply will be in balance through 1980, with a few periods of tightness. Unless there are extreme outside influences, polypropylene, low-density polyethylene, propylene, and ethylene should all be readily available through 1978. (RWR)

35332 **Expander action at the Pb(Hg)/$PbCl_2$ interface.** Barradas, R.G.; Fletcher, S.; Porter, J.D. (Carleton Univ, Ottawa, Ont). *J. Power Sources;* **2**: No. 2, 137-146(Dec 1977).

The expanders, usually lignosulfonic acid derivatives, are added to the negative plates of lead batteries, for the purpose of achieving better discharge rates at low temperatures and longer battery life. The influence of ammonium lignosulphonate on the kinetics of formation of thick films of $PbCl_2$ is described. It is shown that geometric factors need to be considered as well as the influence of the additive on the rates of lattice growth and the nucleation rate constant.

35333 **Manufacture and properties of coated rechargable zinc electrodes.** Forst, H.; Heitbaum, J.; Vielstich, W. (Univ Bonn, Ger). *J. Power Sources;* **2**: No. 2, 177-182(Dec 1977). (In German).

Dendrite formation on zin electrodes can be prevented by the direct application of a semi-permeable, microporous, membrane to the active material. The application of the surface coating is very easy, and it is mechanically stable. The load bearing capability of the coated zinc electrode does not differ from that of an uncoated one. More than one hundred deep discharge-charge cycles can be obtained, and life is limited only by the loss of capacity resulting from the shape change of the electrode.

35334 **Electrochemical measurements and surface studies on acid oxygen carbon electrodes by the use of the ESCA method.** Johansson, L.Y.; Mrha, J.; Musilova, M.; Larsson, R. (Chem Cent, Lund, Swed). *J. Power Sources;* **2**: No. 2, 183-190(Dec 1977).

Results of investigations on the behavior of carbon gas-diffusion electrodes are given. Hydrophobic active carbon electrodes for the electrochemical cathodic reduction of oxygen in acid electrolyte were investigated electrochemically with respect to different ways of Teflon precipitation on the active carbon. The ESCA method was used to characterize the catalyst masses. Teflon in two different states on the active carbon was found by this method. These states have been related to Teflon particle size and are believed to influence the hydrophobicity.

35335 **Anodic sulfidation of iron in molten LiCl—KCl.** Melendres, C.A.; Sy, C.C.; Tani, B. (Argonne National Lab., IL). *J. Electrochem. Soc.;* **124**: No. 7, 1060-1063(Jul 1977).

An understanding of the electrochemical characteristics of the iron sulfide electrode is of interest for the development of cells being considered for application in load leveling and electric vehicles. Preliminary results on the electrochemical formation of sulfide films on iron during electrolysis in molten LiCl-KCl eutectic containing dissolved Li_2S are reported. The shape of cyclic voltammograms obtained is typical of that observed for the formation and reduction of surface films. The effect of scan rate on cathodic waves is shown. The composition of the materials coating the electrode was determined. Possible reactions that could give rise to the coating and sulfide phases are considered. 4 figures. (RWR)

35336 **Charging circuit with SCR and UJT control.** Piwonski, R. *Electron. Eng.;* **49**: No. 592, 22-23(May 1977).

A 12-V, 12-amp battery charger is described which is ideal for charging lead-acid and nickel-cadmium cells. The circuit permits charger shut off when the battery is charged. The moment at which the charging stops is independent of the actual peak point value of the incorporated SCR controlled voltage.

35337 **Battery charger.** *Elektor (Canterbury);* **2**: No. 7/8, 273-277(1976).

This circuit automatically charges the car's accumulator overnight through a switching circuit to avoid the possibility of overcharging.

APPLICATIONS

REFER ALSO TO CITATION(S) 35314, 35315, 35317, 35375, 35503

35338 (CONF-7604144—, pp 84-85) **Battery—electric autos will have "short-run" fuel costs much less than half those of gasoline autos by the early 1980's.** Rocks, L. 1976.

From Battery Council International convention; Mexico City, Mexico (27 Apr 1976).

In Battery Council International convention, 1976.

Operating costs for an electric auto are compared with those for a gasoline-powered auto for a short trip (typically, less than five miles). Depending on gasoline costs, electricity costs for off-peak battery charging, etc., cost per mile for electric autos could fall to 1/5 that of gasoline-powered autos by the early 1980's. No new power plants will be needed if batteries are charged during off-peak hours. The cost of battery replacement will be greater than that of battery charging on a per-mile basis. 3 figures. (RWR)

ENERGY MANAGEMENT AND POLICY

35339 **Changing information environment.** McHale, J. Boulder, CO; Westview Press (1976). 126p. .

A revolution has occurred in the collection, storage, and communication of information. At the core of this revolution, and its most visible component, is electronic data processing via the computer. The computer has shown an impressive ability to handle increasing complexity at greater speeds while decreasing its use of power, cost, and space. In this book, however, Mr. McHale shows how the impact of the information revolution stretches far beyond these specific developments. It lies (1) in the expansion and interlinkage of computer-based systems and their extension into larger areas of automated control; (2) in the convergence and relationship of such systems with concurrently developing communications technologies; and (3) in the ways in which these combine together to create a radically new information environment, whose major impacts will be felt most critically within the next 10 to 20 years. Mr. McHale believes that the emergence of information and knowledge as basic resources signifies profound consequences that will affect the structure of society itself and the institutional and value premises upon which it operates.

ENERGY ANALYSIS AND MODELING

REFER ALSO TO CITATION(S) 35329, 35360, 35370

35340 (TID—27967) **Energy analysis of models of the United States. Annual report.** Odum, H.T.; Alexander, J. (Florida Univ., Gainesville (USA). Dept. of Engineering Sciences). 15 Oct 1977. Contract EY-76-05-4398. 449p. Dep. NTIS, PC A19/MF A01.

This is the annual report between the Systems Ecology and Energy group of the Department of Environmental Engineering Sciences and the Energy Research and Development Administration for 1977. Energy bases for the U.S. were investigated by developing models, making quantitative evaluations, and using simulations to understand trends. Concepts of energy quality, energy spectra, and structure of surviving patterns were studied. Contributions of the environment, labor, and other inputs to economy of humanity and nature were estimated using energy-quality factors providing a better understanding of the ultimate origins of the energy basis of the economy. Energy-analysis methods were compared with those of others using model diagrams to show similarities and differences. Net energies and energy quality factors were calculated with several methods and compared for coal, oil shale, water, air advection, catastrophes, farming inputs, soils, housing, space operations, trade, and main flows of the biosphere. Models were evaluated from the state of Florida showing its basis in renewable and purchased energies. Perspectives on overall energy trends of the United States were obtained by comparing with different energy models of Brazil. A separate abstract was prepared for the Summary and each of 16 other chapters.

35341 (TID—27967, pp 19-43) **Summary of progress.** Alexander, J.F. Jr. 15 Oct 1977.

In Energy analysis of models of the United States. Annual report.

Energy studies of the past 25 years have led to the use of energy models capable of analyzing a broad range of energy-flow relationships through simulation and data organization. This section summarizes the reports on 14 diverse topics investigated ranging from use of energy-circuit models to compare net energy techniques, to the use of the language to model soil formation, earthquakes, value of water, weather systems, regions of the U.S., sociological problems, etc. A mix of disciplines and other university resources is felt to enrich energy analysis and enhance the development of new principles and the refinement of existing principles. The papers are organized under five categories: (1) Work on Concepts, (2) Compari-

son of Energy Analysis Approaches, (3) Energy Methods for Estimation of Embodied Energy Factors (Quality Factors) of Environmental Energy Storages and Flows, (4) Energy Analysis and Models for a State (Florida), and (5) Energy Analysis of Alternative Energy Futures.

35342 (TID—27967, pp 44-77) **Energy analysis, energy quality, and environment.** Odum, H.T. (Univ. of Gainesville, FL). 15 Oct 1977.

In Energy analysis of models of the United States. Annual report.

Energy analysis is defined as the modeling of systems accompanied by an evaluation of the energy flows inherent in the system; a study of unity that is applicable to human, economic, and environmental systems. The theory and process of preparing data and symbols and the diagramming of First-Law heat-equivalent flows, energy costs, energy quality factors, and money flows is described. Aggregate calculations and simulations can be carried out on the basis of the diagrams to determine what the individual parts contribute to the whole. Energy quality, evaluated as a concept and a value measure, is applied to contemporary natural and economic systems. The concepts are then applied to alternative energy sources which are pertinent to current policy decisions. These include the evaluation of primary energy sources by calculating net energy, secondary sources by calculating energy investment, conservation plans by energy savings, and competitive consumer roles by energy effectiveness. 15 references.

35343 (TID—27967, pp 78-94) **Energy models of exchange with simulation of the role of exchange in spatial organization.** Costanza, R. 15 Oct 1977.

In Energy analysis of models of the United States. Annual report.

Diagrams and mathematical modeling of exchange relationships reveal how systems are organized and connected with each other. When applied to the relationship of energy and economics, the model can be used to study how energy resources affect exchange. The two-cell model of exchange is demonstrated in four case studies: (1) resource consumption, using export versus storage of Arab oil; (2) production/consumption pair, using a cell which lacks an external energy source and depends on exchange with a production unit; (3) out-of-phase inputs, such as neighboring systems with different climates; and (4) constant unequal inputs, such as occur in business cycles. The two-cell technique is then applied to landscapes to simulate spatial arrangement in terms of marginal economics and energy flow laws. 8 references.

35344 (TID—27967, pp 95-114) **Efficiency and investment matching of high-quality energy.** Burnett, M.S. 15 Oct 1977.

In Energy analysis of models of the United States. Annual report.

Energy efficiency is variously defined as "First Law" efficiency, energy yield efficiency, and "Second Law" efficiency. Each type has some applications, but is incomplete because some input is lacking. The concept of "Total Efficiency," argued to be more complete, is the ratio of energy output to energy sources measured in equal quality. The argument is made that society, in recognition of resource depletion, should develop an optimal level of technology based on fossil-fuel investment. Results of the model show that initial increase of fossil-fuel inputs, needed for maximum efficiency, form a hump-shaped curve when total efficiency is plotted against the percentage investment in fossil fuel. Transportation is found to exhibit this type of curve. These results can be applied to the use of intermediate technology for developing countries in order to balance high marginal efficiencies and maximum effects with the least cost. 8 references.

35345 (TID—27967, pp 115-166) **Energy diagrams of published energy analysis of others.** Odum, H.T.; Alexander, J.; Swaney, D. 15 Oct 1977.

In Energy analysis of models of the United States. Annual report.

A generalized diagram is developed to standardize the form of model results so that energy analyses can be compared. Tables and diagrams are first given as originally published, then translated to energy-circuit language. A second diagram aggregates flows into externals, outputs to the main economy, and feedbacks from the main economy. Each analysis is then interpreted and alternate pathway results suggested. This procedure was used to make net energy calculations for coal to electricity, petroleum to gasoline, natural gas to electricity, coal gasification, oil shale to gasoline, coal liquefaction to electric production, petroleum to electricity production, natural gas, and surface-mined coal to refined products.

35346 (TID—27967, pp 173-212) **Comparison of energy analysis of oil shale.** Gardner, G.M. 15 Oct 1977.

In Energy analysis of models of the United States. Annual report.

A review of seven net energy analyses of proposed and projected oil shale operations showed yield ratios claimed from .68 to 19.8 as compared to 6 for purchase of foreign oil. Because of anticipated heavy instruments for mining, processing, transporting, and for environmental protection and land reclamation, net energy is defined as the energy flow beyond that needed to process the energy where both flows are expressed in equivalents of the same energy quality. Many energy flows were omitted and many possibilities for underestimation and omission of feedback costs exist where the operations are only conjectural. The only analysis of actual operations were less than 1 with no net energy, but the costs for these operations were mainly for research. No satisfactory net energy analysis is yet available that includes all the energy flows of a pilot operation. 28 references.

35347 (TID—27967, pp 261-286) **Energy analysis of order—disorder phenomenon of man and nature.** Alexander, J.F. Jr. 15 Oct 1977.

In Energy analysis of models of the United States. Annual report.

General systems theory is applied to catastrophic processes in order to develop model language that can simulate natural hazards, such as hurricanes, earthquakes, and fires. Data from the 1976 earthquake in Guatemala is analyzed to determine the order-disorder relationships of the stored and released energy from the primary event coupled with the secondary toppling of structures due to structural failure, natural slides, fire, floods, or volcanic eruption. The amplifier concept was tested and found to be a relative constant for all cities analyzed. The application of this concept may provide net energy information to aid the recycling of matter and determine subsequent productivity after a disaster. 23 references.

35348 (TID—27967, pp 287-296) **Energy-quality calculations for freshwater chemical potential.** Costanza, R. 15 Oct 1977.

In Energy analysis of models of the United States. Annual report.

Energy quality, in this case a factor of the amount of energy needed to convert seawater to fresh water chemical potential, is analyzed along with the energy quality effect ratio. A comparison of chemical-potential calculations based on the difference in salt concentration and the difference in water concentrations shows the values for the first to be $3\frac{1}{2}$ times those of the second. The desalination process is analyzed by process analysis, hydrologic cycle, economic input-output analysis, and marginal production analysis. Results show that the energy costs for desalination make it feasible only in extreme situations, such as a desert. 6 references.

35349 (TID—27967, pp 297-312) **Energy quality of humidity and thermal advection of air in Florida.** Swaney, D.P. 15 Oct 1977.

In Energy analysis of models of the United States. Annual report.

The flows of humidity and thermal advection of nine Florida cities are analyzed as factors in energy quality that affect other energy flows in the environment. The quality factor is expressed in coal and solar equivalents. The study is restricted to wind moving heat horizontally from one place to another and causing advection, which occurs only in the presence of spatial temperatures and a nonzero wind velocity. It is shown by energy inputs and outputs of electric dehumidifiers that energy is saved when water vapor is flushed away by atmospheric conditions. The author cautions that values obtained for specific locations will vary and should not be constructed as precise energy values. 10 references.

35350 (TID—27967, pp 313-337) **Historic and current energy analysis of Florida.** Sipe, N. 15 Oct 1977.

In Energy analysis of models of the United States. Annual report.

Energy flow analysis in Florida is expanded to include the evolution of complexity as the state has developed. Energy circuit diagrams are made for three historical periods--Primitive, Colonial, and Limited Agriculture--on the basis of the kinds and availability of energy sources. New pathways are needed to reflect the introduction of complexities to the system. The State reached a steady-population state during the primitive, pre-agricultural period. A shift from a fish and shellfish diet to deer was likely a response to easier food gathering than to resource depletion. Competition between settlers and Indians for natural resources took place during the Colonial period, when population growth was subsidized by trade from abroad. Continued exports of luxury items such as fruits and vegetables and an influx of tourists--in return for fossil fuels--has made Florida vulnerable to declining demands for its exports as energy becomes less available. State policymakers are advised to plan for alternatives to these exports to compensate for lower energy futures. 12 references.

35351 (TID—27967, pp 338-377) **Statistical test of energy models for prediction of urban growth in Florida.** Regan, E.J. Jr. 15 Oct 1977.

In Energy analysis of models of the United States. Annual report.

Data were collected from 67 counties in Florida to analyze the interaction of environment and development and to test the response of growth to environmental energy resources. Comparison of results from eight production models indicates that spatial distribution of urban growth is associated with natural energies and demonstrates the validity of energy analysis in predicting patterns of urban growth. An evolution of soil-based to fossil energy systems is shown to have modified the production function with time. The model considers both vegetation and urban production, which includes the industrial, agricultural, and recreational sectors. Renewable natural energies (solar, rain, wind, tide, and wave) enter directly into the soil and urban production and interact with geologic uplift. Natural energy flows and storages of the urban sector interact with fossil fuels. 26 references.

35352 (TID—27967, pp 378-399) **Energy analysis of some space operations.** Noyes, G. 15 Oct 1977.

In Energy analysis of models of the United States. Annual report.

Energy analysis of space operations is used to estimate the net energy potential of space platforms for transmitting solar energy and to justify the national investment in this type of activity. Energy and money flows (categorized as separable and inseparable costs), storages, and associated processes are included in a model of the National Aeronautics and Space Administration(NASA) Skylab Project. Data from the Saturn I-B and Saturn V launches is analyzed in terms of the launch vehicle's energy and dollar costs. This is followed by a breakdown of life support and human service costs, earth resources photography, and conventional aerial photography. It is shown that (1) lift energy costs decrease as the payload weight increases, (2) human life support costs, while high, are invaluable as a source for information, and (3) photographic costs are less than for comparable aerial photography. It is anticipated that costs of similar activities will decrease with multi-mission launches, longer missions, and other strategies to maximize power and efficiency. 16 references.

35353 (TID—27967, pp 400-413) **Some aspects of energy use in housing.** Brown, M.; Arrington, L. 15 Oct 1977.

In Energy analysis of models of the United States. Annual report.

Net energy calculations and summary diagrams are presented for three residential alternatives: solar heaters, insulation, and reflective glazing. The energy costs of solar water heating versus shading by trees are compared, and a net deficit is shown if the trees are cut down in order to install solar collectors. Solar collectors do seem to be competitive, however, in areas where it is feasible to locate them away from the shaded house and where the temperatures are not too high. Comparisons of an insulated versus an uninsulated house show a 60/1 yield ratio and a net saving of both energy and dollars. Comparisons of windows glazed with reflective film and windows left unglazed show a small net energy for east and west exposures. The slight gain is not felt to be as good an investment as some other conservation techniques with higher yield ratios. Ratios of 6/1, the present figure for Arab oil, are felt to be the minimum level to be competitive.

35354 (TID—27967, pp 414-429) **Energy analysis and model of intermediate agriculture.** Burnett, M.S. 15 Oct 1977.

In Energy analysis of models of the United States. Annual report.

High costs and short supplies of energy affect energy-intensive food production in industrial as well as developing countries. An Arkansas farm is used to analyze intermediate technology of an agro-ecological system approach as compared to conventional energy-subsidized agriculture. A visual model of energy and materials flow is evaluated in coal equivalents. The farm, which provides support for four people and a product for the economy, is found to have a significantly low investment ratio and is thus less dependent on energy prices and supply factors. Only a quarter as much fossil fuel is needed for the Arkansas farm than for a similar size family in the general economy. A three-stage scenario is developed for replacing bankrupt energy-subsidized agriculture with intermediate agriculture. The labor for this technology is expected to come from urban areas of high unemployment. As energy shortages increase, workers would move onto the farmlands and form a decentralized society.

35355 (TID—27967, pp 430-447) **Energy analysis of Brazil.** Odum, H.T. 15 Oct 1977.

In Energy analysis of models of the United States. Annual report.

A study of how money and energy are attached to bring about growth in Brazil is used to gain insight in the U.S. energy system. Brazil, which maintained an accelerated growth during the 1973 to 1977 period, provided statistical data for analysis and comparison with U.S. data. Energy and money flow are summarized in a diagram. A large area is seen to provide free input of solar energy that contributes, along with rain and soils, to Brazil's economic base. Brazil's high-quality energy matching in feedback investment is only 1 to 6 compared to 2.5 to 1 for the U.S. Economic growth is anticipated to continue until a higher, less-competitive, investment ratio develops. When high net energy foreign fuels are no longer available or when environmental density is less competitive, growth can be expected to stop. The pattern is compared with Iran (net energy 40/1 or more) which can be expected to use its oil production for self-growth through the purchase of goods, services, and equipment. U.S. growth ceased when production began going directly to oil countries and for investments in countries of low energy ratios.

ECONOMICS AND SOCIOLOGY

REFER ALSO TO CITATION(S) 34670, 35211, 35340, 35341, 35342, 35345, 35350, 35351, 35354, 35355, 35364, 35371, 35387, 35420, 36028

35356 (ANL/SPG—2) **Social opportunity cost of capital: empirical estimates.** Townsend, S. (Chicago Univ., Ill. (USA). Dept. of Economics). Feb 1978. Contract W-31-109-ENG-38. 37p. Dep. NTIS, PC A03/MF A01.

This report develops estimates of the social-opportunity cost of public capital. The private and social costs of capital are found to diverge primarily because of the effects of corporate and personal income taxes. Following Harberger, the social-opportunity cost of capital is approximated by a weighted average of the returns to different classes of savers and investors where the weights are the flows of savings or investments in each class multiplied by the relevant elasticity. Estimates of these parameters are obtained and the social-opportunity cost of capital is determined to be in the range of 6.2 to 10.8%, depending upon the parameter values used. Uncertainty is found to affect the social-opportunity cost of capital in two ways. First, some allowance must be made for the chance of failure or at least of not realizing claims of a project's proponents. Second, a particular government project will change the expected variability of the returns to the government's entire portfolio of projects. In the absence of specific information about each project, the use of the economy-wide average default and risk adjustments is suggested. These are included in the empirical estimates reported. International capital markets make available private capital, the price of which is not distorted by the U.S. tax system. The inclusion of foreign sources slightly reduces the social-opportunity cost of capital. 21 references.

35357 (HCP/L60866—2) **Development of a financial management program for city of Gillette and town of Moorcroft. Volume II. Financial management program: City of Gillette. Final report.** (Lankford (Duane G.) and Co., Denver, Colo. (USA); Ernst and Ernst, Denver, Colo. (USA)). 15 Jul 1977. 257p. (FEA—77-8-5(Vol.2)). Dep. NTIS, PC A12/MF A01.

The development of large-scale energy resources in a region causes strain on local government revenues and services. This handbook presents a financial-management program for the City of Gillette, Wyoming, where large deposits of strippable low-sulfur coal exist. This volume contains specific detailed findings and recommendations and other relevant data on financial management systems and financing programs for the City of Gillette. (MCW)

35358 (HCP/L60866—03(Vol.3)) **Development of a financial management program for city of Gillette and town of Moorcroft. Volume III. Financial management program: town of Moorcroft.** (Lankford (Duane G.) and Co., Denver, Colo. (USA); Ernst and Ernst, Denver, Colo. (USA)). 15 Jul 1977. 144p. (FEA—77-8-5(Vol.3)). Dep. NTIS, PC A07/MF A01.

The development of large-scale energy resources in a region causes strain on local government revenues and services. This handbook presents a financial management program for the Town of Moorcraft in Wyoming, where large deposits of low-sulfur coal exist. The general approach was to assess the status of financial management systems in effect at the Town of Moorcraft, identify its weaknesses, and suggest improvements needed in the form of a plan of action. (MCW)

35359 (HCP/L60866—04) **Development of a financial management program for city of Gillette and town of Moorcroft. Volume IV. Financial management assessment handbook for local government. Final report.** (Lankford (Duane G.) and Co., Denver, Colo. (USA); Ernst and Ernst, Denver, Colo. (USA)). 15 Jul 1977. 95p. (FEA—77-8-5(Vol.4)). Dep. NTIS, PC A05/MF A01.

The development of large-scale energy resources in a region causes strain on local government revenues and services. This handbook presents a financial management assessment for the City of Gillette and the Town of Moorcraft in Wyoming, where huge deposits of strippable low-sulfur coal exist. This generalized manual may, however, be adapted to other municipalities to identify and rank weaknesses in the financial management systems. The Assess-

ment Handbook utilizes a questionnaire to provide for a basis to rate the financial management system. (MCW)

35360 (TID—27967, pp 167-173) **Meso-model of the economy of the United States for comparison of economic and energetic analysis.** Costanza, R.; McCallister, A.; Boyles, J. 15 Oct 1977.

In Energy analysis of models of the United States. Annual report.

The U.S. economy is analyzed in an aggregated 13-sector input-output model. Details of the method are presented and compared with corresponding energy-flow diagrams. The static input-output table is found to lack visual impact and to not reveal the relationships of system storages and flows found in the diagram. However, work is expected to improve the table in time. The preliminary table can be used to determine embodied energies at a specific time, while further modifications will allow renewable energy sources and labor to be included.

35361 (TID—28341) **Mitigating adverse socioeconomic impacts of energy development: present programs and mechanisms; further policy options.** Moore, K.D.; Hammond, D.M.; Gilmore, J.S.; Flory, D.K.; Coddington, D.C.; Donald, D.W. (Denver Research Inst., Colo. (USA); Bickert, Browne, Coddington and Associates, Inc., Denver, Colo. (USA)). 19 Jan 1978. Contract EX-76-C-03-1379. 96p. Dep. NTIS, PC A05/MF A01.

New energy development and/or energy policies may lead to serious problems for communities accommodating sudden growth, new stresses; and conflicts in local economic and institutional relationships. Potential problems include: boom town impacts (infrastructure financing shortfalls, housing shortages, abandonment, social disruption) or conflict impacts (changes in comparative economic advantage, competition for scarce resources, interjurisdictional and regulatory conflicts, social disruption). Effective mitigation of adverse impacts will involve satisfactorily addressing known problems under each of these issues. In order to determine whether a program or institution is actually accessible and workable in meeting these needs, it is also necessary to take into consideration several factors concerning the circumstances under which it will need to be employed: communities with boom town problems will tend to be small and rural and to have little public administrative expertise; needs will frequently be immediate once they are perceived; local socio-economic and physical environments have important differences in Western, Central Appalachian, Outer Continental Shelf (OCS), and Indian communities. These differences in local environment produce differences in the seriousness of problems and in the applicability of programs and policy options; however, there is remarkable similarity in the existence of both boom town and conflict impact categories in all communities. The last two sections array present Federal, state, industry efforts and evaluate them based on their ability to meet the detailed performance criteria for each issue area and to be accessible and workable in the local environments described.

35362 (TID—28342) **Socioeconomic impact mitigation mechanisms in six states: categories, generalizations, and unresolved issues. Appendix. Description of state approaches to energy impact mitigation.** Gilmore, J.S.; Flory, D.K.; Hammond, D.M.; Moore, K.D.; Coddington, D.C. (Denver Research Inst., Colo. (USA); Bickert, Browne, Coddington and Associates, Inc., Denver, Colo. (USA)). Sep 1977. Contract EX-77-C-03-1379. 132p. Dep. NTIS, PC A07/MF A01.

The appendix contains detailed data for Colorado, Illinois, Kentucky, Louisiana, Massachusetts, and Montana dealing with their approaches to energy impact mitigation. A bibliography is provided in reference to each individual state. (MCW)

35363 **Families in the energy crisis: impacts and implications for theory and policy.** Perlman, R.; Warren, R.L. Cambridge, MA; Ballinger Publishing Company (1977). 252p. .

This book reports the effects of the 1973—1974 and the 1977 energy crisis on 1440 families in the metropolitan areas of Hartford, Connecticut; Mobile, Alabama; and Salem, Oregon. In terms of the author's own analytical framework, it deals with issues of equity, with the relationship between attitudes and behavior, and with family tasks that were affected by actions of government and private establishments. The reported data show that, for most American families, events following the Arab oil embargo did not constitute a severe disruption or crisis. But, its impacts were serious for some lower-income families, older people, and minority group households. The authors' analytical approach to such problems has important implications for energy policy makers and for social scientists interested in the interactions between families and other institutions in society. Elements of the crisis model are discussed.

ENVIRONMENT, HEALTH, AND SAFETY

REFER ALSO TO CITATION(S) 35340, 35341, 35342, 35349, 35951, 35963, 35979, 35981, 35986, 35995, 36004, 36007, 36011, 36015, 36027, 36028

35364 **Social burdens of environmental pollution: a comparative metropolitan data source.** Berry, B.J.L. (ed.). Cambridge, MA; Ballinger Publishing Co. (1977). 618p.

Which social groups within metropolitan America bear the burdens of polluted air and water, unwanted sound, and the risks associated with high solid-waste generation rates. This question is addressed in this study both in a detailed case study of Chicago and a comparative assessment of the situation in a national sample of twelve other metropolitan regions—Baltimore, Providence, St. Louis, Rochester, Cincinnati, Jacksonville, Birmingham, Oklahoma City, Denver, Seattle, San Diego, and Washington, D.C. A detailed examination of the social geography of each metropolitan region, based upon 1970 census data, is followed by presentation of multiparameter information for the years 1971—1973 on air pollution, water quality, noise, and solid wastes—more than 500 original maps in all, utilizing data drawn from EPA's data banks and from original studies. Pollution problems are compared with the social maps, and both exposure levels and the population at risk is calculated, for each social group. The study concludes with a discussion of the likely distribution of benefits if the nation's environmental quality standards are achieved.

35365 **Protection in the nuclear age.** Washington, DC; Defense Civil Preparedness Agency (1977). 70p.

Much has been done to prepare for a possible nuclear attack. Public fallout shelter space has been located for millions. Civil-defense systems also include warnings and communications networks, preparations to measure fallout radiation, emergency operating centers to direct lifesaving and recovery operations, emergency broadcasting stations, local governments organized for emergency operations, and large numbers of citizens trained in emergency skills. If an enemy should threaten to attack the United States, the entire Nation would be mobilizing to repulse the attack, destroy the enemy, and hold down our own loss of life. Much assistance will be available from local, State, and Federal governments, from the U.S. armed forces units in your area, and from your neighbors and fellow Americans. If an attack should come, many lives would be saved through effective emergency preparations and actions. This handbook contains basic general information on nuclear attack. This general guidance supplements specific instructions issued by local governments. Since special conditions exist in some communities, local instructions issued by local governments may differ slightly from this general guidance. In such cases, the local instructions should be followed.

ENERGY RESOURCES

REFER ALSO TO CITATION(S) 35343, 35344, 35350, 35351, 35360, 35377, 35378, 35383, 35959, 36008, 36027

35366 (CONF-7510172—P2, pp 893-900) **Satellite and airplane remote sensing of natural resources in the State of Washington.** Scott, R.B.; Harding, R.A. (Dept. of Natural Resources, Olympia, WA). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The State of Washington Department of Natural Resources (DNR) has multi-disciplinary statewide governmental and proprietary responsibilities. The DNR obtains and indexes state-wide aerial photography (black and white, color and FCIR) which is used for many purposes including inventory. The DNR, with USDI-EROS Contract No. 14-08-001-12863, developed potential applications for LANDSAT data, and is a key participant in the joint USDI-EROS, NASA-AMES and Pacific Northwest Regional Commission Land Resource Inventory Demonstration Project.

35367 (CONF-7510172—P2, pp 907-910) **Utilization of remote sensing technology in natural resources development in Bangladesh.** Hossain, A.; Chaudhury, M.U. (Bangladesh National Landsat Programme, Dacca). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The paper traces the history of utilization of remote sensing technology in Bangladesh starting with aerial photography and entering the phase of utilizing LANDSAT imageries. In its rudimen-

tary stage of development, the LANDSAT imageries have already indicated immense possibilities of utilizing space technology in discovering and exploiting the natural resources of Bangladesh. It appears that the rate of accretion of new landmass in the Bay of Bengal can be studied and winter crop inventory can be made. International co-operation is also forthcoming beginning with an assistance already given by ERIM.

35368 (CONF-7510172—P2, pp 925-929) **Possible areas of application of remote sensing technology in Sierra Leone: some preliminary work and immediate application.** Kamara, C.S. (Njala University Coll., Sierra Leone); Gabisi, A.H. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The need and relevance of the concept and technology of remote sensing for the generation of more up-to-date maps and results is presented by giving examples of completed and continuing projects up to the present stage of the science. Areas of preliminary investigation to account for local differences and possible contributions to the development of the technology are listed. Immediate areas of practical application of ERTS-1 imagery are also listed for the benefit of ECA member countries like Sierra Leone. An attempt is made to propose an agency and subagencies which can coordinate and work on the projects respectively. The need for the support of the Sierra Leone Government in utilizing remote sensing technology is expressed, and suggestions for a possible regional cooperation between Sierra Leone, Liberia and Guinea is proposed.

35369 (CONF-7510172—P2, pp 1029) **Mineral resource investigations in South America using Landsat data.** Carter, W.D. (Geological Survey, Reston, VA). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Synoptic, multispectral LANDSAT images of the South American continent are providing a new look at one of the largest under explored areas of the Earth. Natural resources include vast areas of timber, grasslands for grazing, abundant water supply for hydroelectric power, and a great variety of mineral and petroleum resources that are beginning to be developed to meet world requirements. The surface of the continent is rapidly changing in response to current land use demands; the accelerated industrial development of Brazil and Venezuela is symptomatic of these changes. The oil-rich countries of Equador, Peru, and Bolivia are feeling the pressures of world resource needs and are beginning to realize the effects of increased development. Remote sensing by side-looking airborne radar and satellite imaging is playing an important role in this development. This paper describes a cooperative effort between the U.S. Geological Survey and similar agencies of several South American countries to investigate the applications of satellite data to mineral and energy resource exploration. Informal arrangements for data and information exchange were devised to insure that each country would have an opportunity to participate in the experiment. Venezuela, Colombia, Peru, Chile, Bolivia, Brazil, and Argentina have all participated to varying degrees.

35370 (TID—27967, pp 213-260) **Energy analysis and models of soil formation.** Regan, E.J. Jr. 15 Oct 1977.

In Energy analysis of models of the United States. Annual report.

Three types of Florida soil are analyzed as energy sources by estimating the costs of soil formation and soil energy storage expressed in coal and solar equivalent units. Soil-forming factors include the parent materials, climate, the CO_2 metabolism of roots and soil organisms, and the geologic relief as a result of water moving down a slope. A period of 375—525 years is found by simulation to be needed to form two feet of soil. The solar costs for mineral soil formation in Florida are found to be comparable to the solar costs for energy, while the costs for organic soil are comparable to those of collected wood. Soil is found to be undervalued because only the costs of obtaining and moving topsoil have been factors in its market value. 46 references.

NUCLEAR ENERGY

REFER ALSO TO CITATION(S) 34543, 34544, 34545, 34557, 34558, 34559, 34560, 34571, 34572, 34576, 34577, 34592, 34593, 34619, 34620, 34628, 34671, 35103, 35203, 35365

WASTE HEAT UTILIZATION

REFER ALSO TO CITATION(S) 34626, 35439

CONSERVATION

REFER ALSO TO CITATION(S) 35383, 35420, 35438, 35462, 35464, 35466, 35477, 35478

35371 (EPRI-EM—313-SR, pp 1.1-1.6(Vol.II)) **Efficient end-use of energy: general principles.** Smith, C.B. 1976.

From EPRI workshop on technologies for conservation and efficient utilization of electric energy; San Diego, CA, USA (26 Jul 1976).

In Proceedings of an EPRI workshop on technologies for conservation and efficient utilization of electric energy. Volume I. Executive summary; Volume II. Working papers.

General principles of energy management are discussed and compared and five strategies for energy management are compared in terms of cost, complexity, time for implementation, and relative benefit. (LCL)

35372 (EPRI-EM—313-SR, pp 3.4-3.14(Vol.II)) **Energy management regulation and legislation.** Martin, L.H. 1976.

From EPRI workshop on technologies for conservation and efficient utilization of electric energy; San Diego, CA, USA (26 Jul 1976).

In Proceedings of an EPRI workshop on technologies for conservation and efficient utilization of electric energy. Volume I. Executive summary; Volume II. Working papers.

Areas that deserve emphasis in a research program proposed by the Electric Power Research Institute (EPRI) in order to identify, develop, and implement electric energy-conservation technologies are suggested. The suggestions are based on directives, expressions of priority, and trends identified in an analysis of pertinent energy-management regulations and governmental policy. This discussion is limited to the subject of conservation technologies as applied to the end use of electricity. Discussion of supply technologies is omitted except where its inclusion is required to effectively demonstrate concepts in the subject area.

35373 **Energy savings in the investment policy of french companies. I. Behavior of industrialists.** Castagne, M.; Picard, J.J. (Inst Natl Polytech de Lorraine, Fr). *Rev. Energ.;* **28**: No. 297, 473-477(Oct 1977). (In French).

Twenty years of "cheap" energy favored industrial structures that are major consumers of energy. The two main sectors in this field are the steel industry (25% of industrial consumption) and the chemical industry (19%). They are followed by the mechanical and electrical industries (11%) and construction materials (10%). In a previous article, it was shown that in order to reduce energy consumption it is necessary to increase investment costs. The present study starts off from the results of this previous article and then sums up the present situation, taking into account a survey made among industrialists, various financial groups and administrative bodies. It is stated that the leading spokesmen of the French industry suggest: a firm strengthening of the norms of construction to avoid any deliberate waste; a substantial financial assistance by the State to make appropriate investments; a stepped-up research effort by the State.

SUPPLY, DEMAND, AND FORECASTING

REFER ALSO TO CITATION(S) 34488, 35460, 35477

35374 **Return to an energy self-sufficient Western Europe.** Odell, P.R.; Rosing, K.E. (Erasmus Univ., Rotterdam). *J. Inst. Fuel;* **50**: No. 405, 185-194(Dec 1977).

The development of Western Europe was historically based on the use of indigenous energy resources. However, largely as a result of the activities of the international oil companies, the region became increasingly dependent on imported energy after 1950. It now seems that the period 1950-75 will prove to have been a relatively short-lived aberration from the norm in respect to the continent's energy supply and that there will now be a steady if not spectacular return to an economic system that relies mainly on the use of indigenous energy. In the short term both the demand response to higher energy prices and deliberate changes in the structures of society will diminish the annual rate of increase in energy use. Within this context of a much lower-than-hitherto-expected post-1975 demand for energy, indigenous resources in Western Europe can be developed to meet an increasing share of the region's total requirements. Until, or even beyond the year 2000, the main elements in the fundamentally changed supply pattern will be the availability of oil and gas from the world's most important new hydrocarbon province, the North Sea basin. Given appropriate national policies for the exploitation of those reserves, coupled with appropriate cooperation between governments and oil companies in respect of their development, North Sea oil and gas could supply over 50% of Western Europe's total energy needs during this period.

Increasingly, however, other petroliferous regions of Western Europe's exensive off-shore areas willalso be supplemented in the longer term by the use of energy from indigenous coal. Indeed, coal could become the single most important energy source in the second quarter of the 21st century, given the development of new technologies on both the supply and the demand sides. Such conventional energy resource development can thus largely eliminate Western Europe's demand for oil imports.

35375 (CONF-7604144—, pp 14-19) **Energy outlook and its implications on the electric battery industry.** Nerf, R.B. (Exxon Chemical Co., Houston, TX). 1976.

From Battery Council International convention; Mexico City, Mexico (27 Apr 1976).

In Battery Council International convention, 1976.

Because of the long lead times involved, it is necessary to project the energy situation 10 or 15 years into the future. Projections are made in an attempt to clarify basic issues and provide a useful frame of reference. The present and near-future situation in the U.S. is discussed first, then the world outlook is examined and some implications derived from the scenario are presented. Batteries can find a place in electric-powered vehicles, peak shaving, and storage of solar energy. 9 figures. (RWR)

35376 **Poverty or progress: energy problems and prospects.** Gair, G.F. *N.Z. Energy J.;* **50**: No. 12, 188-190(25 Dec 1977).

New Zealand Manufacturers' annual convention, Wellington, 12 Oct 1977.

In a review of the presentations at the International Energy Agency meet in Paris in the fall of 1977, the author noted that 19 developed nations agreed on a program of 12 principles to provide the positive response that must be made to meet the energy problem. To succeed, the principles must reflect themselves as quickly as possible in the development of national policies--greater effort in conservation and efficient use of energy; new impetus into research and development; progressive easing of dependence upon imported oil; programs for greater public support for and involvement in energy economies. New Zealand signed participation in a wind energy research project and will support one in coal technology. It did not actively support nuclear energy development. With the depletion of liquid fuels for transportation purposes, problems are cited. New Zealand does have abundant geothermal and hydro as static energy supplies. New Zealand must make plans for domestic exploration for petroleum to cut down on the cost of imported oil. Plans for substantially increasing indigenous coal production and increasing natural gas supplies are reviewed. It is also the government's hope that the larger elements of the South Island manufactured gas industry can be maintained by the use of liquefied petroleum gas as a feedstock, providing that satisfactory transport and pricing can be arranged. (MCW)

35377 **World balance between energy requirements and resources by the year 2000. I. Evolution and regionalization of the problem.** Frisch, J.R. (Electr de Fr). *Rev. Energ.;* **28**: No. 297, 444-459(Oct 1977). (In French).

A complete balance sheet of world energy resources by major world regions is presented. Three years are taken as reference points: 1950, 1974, and 2000. The major regions considered are: North America; Western Europe; Japan, South Africa, Oceania, etc. (the "West"); the USSR, Eastern Europe (the "East"); China, the rest of the Third World (the "Third World"). The first installment of the article contains an introduction, an explanation of the methodology employed, the dynamics of the energy requirements (evolution of world consumption, evolution of large regional sub-units, evolution by zones), and an inventory of the resources (coal, petroleum, natural gas, hydraulic resources, nuclear fuels, novel energies). An appendix contains numerous statistical tables or world energy consumption in 1950, 1974, and 2000 in Mtec and percentagewise. The increase in consumption between the years 1950-1974 and 1974-2000 is also given in Mtec and percentages.

35378 **Risks of energy shortage in the world level.** Ailleret, P. *Rev. Energ.;* **28**: No. 296, 89-102(1977). (In French).

The political risks and the risks connected with the depletion of energy resources are considered. The questions are asked: when can a take-over by new energies be expected, and what types of energy are really critical. Various types of possible new energy sources are considered and evaluated to be of little practical importance before the end of the century. The possibilities of energy savings and the future energy needs are evaluated. Specific and non-specific uses of petroleum are considered and conversion of the latter toward coal or nuclear energy is urged.

POLICY, LEGISLATION, AND REGULATION

REFER ALSO TO CITATION(S) 35344, 35372, 35378, 35392

35379 **Eleventh general report on the activities of the European Communities in 1977.** Brussels; Commission of the European Communities (1978). 333p.

The 1977 activities in the European Communities are summarized. Chapter I surveys the general economic situation with a review of the prospect for enlargement with applications from Portugal, Spain, and Greece. Chapter II summarizes Community policies while external relations of member states are reviewed in Chapter III. Chapter IV is a summary of 1977 activities on regulations and laws. (MCW)

35380 **Programme of the Commission for 1978.** Brussels; European Atomic Energy Community (1978). 52p.

Mr. Jenkins, President of the Commission, first examines the problem of the economy and the level of its unemployment in the Community, resulting in a lack of growth. He than presents the two-fold aim of the Commission--to instigate emergency action to sustain industries that are no longer fully competitive and to promote economic growth to provide employment and prosperity. He then examins the energy and agriculture sectors. Two obligations cited for the Community are: (1) to defend Community interests in the energy field in relation to Third World Countries, and (2) to make clear the connections between energy policy and the general economic strategy. Negotiations are underway for enlargement of the community with applications being considered for Greece, Portugal, and Spain. A memorandum annexed to the address contains additional material on building an integrated economic unit, the European citizen and his environment, Europe in the world, and enlargement of the community. (MCW)

35381 **Policy for energy.** Toynbee, P.A. (New Zealand Coal Research Association, Gracefield). *N.Z. Energy J.;* **50**: No. 12, 198-200(25 Dec 1977).

The author presents what he terms a practical and workable energy policy. Albeit not very palatable. He first calls for new developments that can contribute to the long-term solution of New Zealand's energy problems and keep these developments under constant review, investigation, and encouragement. A policy for the reduced use of the private motor car and all internal combustion engines must be considered. Hydroelectric and geothermal energy resources should be developed rapidly. The search for natural gas and oil must continue in the North Island and especially in the South Island. A policy for the distribution of gas as a domestic fuel and for power generation should be adapted throughout New Zealand. Economic studies should be carried out on the transportation of LNG to the South Island and on the gasification of Southland lignites. The production and supply of coal must be developed rapidly and as little coal as possible should be used for power generation in thermal stations. (MCW)

35382 **World energy policy.** Thring, M.W. (Univ. of London). *J. Inst. Fuel;* **50**: No. 405, 179-184(Dec 1977).

In order to ensure a survival of our civilization through the next century, the following conditions must be satisfied: 1. Every family in the world must have a decent education and be able to earn a decent standard of living. 2. The gap between the standard of living of the rich countries and the poor must be substantially eliminated. 3. The rich countries must come down and the poor countries come up over the next 30 years to the present world average figure of energy consumption, namely around two tons of coal equivalent per head per year. This means a 3% pa fall in Britain's energy consumption every year for 30 years. 4. The premium fuels (oil, gas and electricity) must be used only for the premium purposes for which they are uniquely suitable. 5. We must develop as quickly as possible a way of bringing all the world's coal resources to the surface without men going underground. Telechiric mining can do this. 6. Fuel economy in the broadest possible sense must be practized as if coal cost two to three times as much as at present and the premium fuels six times as much. All electricity must be generated by total energy systems. 7. We must have a very active policy of research and development on the renewable energy sources, especially solar and wind, so that when the coal runs out, civilization will still have the benefits of the industrial revolution.

35383 **European energy policy: distant mirage or tomorrow's reality.** Simonet, H. (Cons des Minist des Commun Eur, Fr). *Rev. Energ.;* **28**: No. 296, 15-22(1977). (In French).

Some illusions entertained in Europe about how to deal with the energy crisis are pointed out, the achievements and the shortcomings evident so far are considered, and some proposals by the Commission of the European Communities on energy conservation and development of the existing and new resources are discussed. Problems of management are emphasized.

35384 **United States energy policy.** Frankel, P.H. *Rev. Energ.;* **28**: No. 296, 23-26(1977). (In French).

The energy policy which the Carter administration is attempting to follow is explained. Doubt is expressed whether the U.S. would be able to achieve its goals of cutting oil imports. The

negative impact of such a failure on the rest of the world is emphasized.

35385 Options of long-term energy strategy of Japan. Sakisaka, M. (Natl Inst for Res Adv, Fr). *Rev. Energ.;* **28**: No. 296, 27-39(1977). (In French).

In view of the seriousness of energy problem for the future of Japan, N.I.R.A. (National Institute for Research Advancement) has tried to establish the long-term energy policy of Japan with the close cooperation of seven other specialized institutes since the beginning of 1975. The main results of these studies and analyses are presented. The amount of energy consumption in Japan and the possible level of primary energy supply are reviewed. The dependence on oil is stressed. It is shown that the development program of nuclear power generation is lagging behind the requirements. Desirability of diversification of the imported energy sources, in particular greater use of LNG and coal, is pointed out. Likewise, the need for more effort for economic and technical cooperation with oil-producing nations, for energy conservation, research and development of new energy resources, is indicated. The basic strategy of diversification of the sources of energy supply is emphasized.

35386 Few aspects of the Soviet energy policy. Grenon, M. *Rev. Energ.;* **28**: No. 296, 40-49(1977).

The article considers mainly the Soviet policy with regard to the production of coal and oil. The problems posed by the fact that 80% of the industrial capacity and 75% of the population of the USSR are located west of the Urals, and that some 80% of the energy resources are found to the east, at an average of 3 or 4,000 km for the centers of consumption, are emphasized. Reserves and resources of various Soviet coal- and oil-producing regions are discussed. The development of offshore drilling is predicted.

35387 Scope for energy substitution policy in India. Parikh, K.S. (Inst Int pour l'Anal des Syst Appl, Laxenburg, Auria). *Rev. Energ.;* **28**: No. 296, 50-57(1977). (In French).

Based on some assumptions about the growth of the population (637 mil. in 1978, 870 mil. in 2000) and economic growth rates (6% p.a. in 1978-1983, 7% p.a. in 1990-2000) in India, the requirements in energy and the possibilities of fuel substitution are discussed. It is found that more than a third of the oil can be substituted by using currently available, old and proved technologies alone. If likely new technologies are introduced, scope exists for even larger substitution of oil economically.

35388 Few aspects of the energy policy in Algeria. Keramane, A. (SONELGAZ, Fr). *Rev. Energ.;* **28**: No. 296, 58-77(1977). (In French).

The paper presents guidelines of the Algerian national energy policy, the programs and actions carried out during the 1967-1977 period, and the prospects until 1985 in the field of gas and electricity to satisfy home demand. Known natural gas reserves are estimated at 2,800 billion m^3 and possible reserves are around 4,300 billion m^3. The energy balance for the period till 1985 is forecast and plans in the development of natural gas supply network and electric power generation and transmission are outlined.

35389 Search for a reasonable world energy policy: some basic considerations and options. Attiga, A.A. *Rev. Energ.;* **28**: No. 296, 78-86(1977). (In French).

An attempt is made to outline the main elements that could constitute a reasonable world energy policy. The opportunity of direct cooperation between the oil-exporting and -importing countries and the substantial increase in the price of oil since 1973 are emphasized as favorable factors. It is concluded that the following policy directions should be followed: diversification of energy supplies; conservation of oil and gas; pricing of oil and gas on the basis of their cost of replacement from other sources of energy; diversification of the economics of the oil-exporting countries.

FOSSIL FUELS

REFER ALSO TO CITATION(S) 35386, 35388, 35389

COAL

REFER ALSO TO CITATION(S) 34451, 34488

35390 Coal resources, characteristics, and ownership in the U.S.A. Noyes, R. (ed.). Park Ridge, NJ; Noyes Data Corporation (1978). 357p.

Coal currently occupies less than 18% of thee nation's energy market. Commercial, household, and transportation uses of coal have dropped to almost nothing. In industry, coal declined from 46% of the energy consumed in 1950 to 09.5% in 1975. Only in the electrical generation sector has coal held its own. In 1950 some 45% of the energy consumed by electric utilities came from coal. In 1975 it was just a point lower–44%. Coal reserves are adequate for at least a century at present consumption rates, while the reserves of the alternative fossil fuels, petroleum and natural gas, are probably measurable only in decades. The probable course of the petroleum supply picture is further beclouded by economic and political factors, making any kind of probability forecast next to impossible. In the late 1960s, the abrupt rise of environmentalism and the ensuing passage of legislation, setting standards of air quality, imposed direct restrictions on the sulfur content of coal used for the generation of heat. The scarcity of coals with low sulfur content in the Eastern U.S. and the lack of an effective and economic method of sulfur removal have helped to limit the redevelopment of the nation's abundant and available energy source. The variations in properties of coal have given rise to geographical patterns of coal mining operations for specific industrial purposes. This book presents an accurate picture of U.S. coal reserves, the nature and composition of the coal, and of the land and minerals ownership. Numerous references are included at the close of the 6 chapters. An extensive bibliography concludes the book.

PETROLEUM

REFER ALSO TO CITATION(S) 34515

NATURAL GAS

REFER ALSO TO CITATION(S) 34533, 34534

35391 (CONF-771151—1) **Gas option.** Linden, H.R. (Institute of Gas Technology, Chicago, Ill. (USA)). 1977. 15p. TIC.

From 89. symposium of the National Association of Regulatory Utility Commissioners; New Orleans, LA, USA (15 Nov 1977).

The premise that natural gas has a very limited future as a major contributor to U.S. energy supply is challenged. It is argued that pipeline gas need not be any scarcer than electricity or liquid fuels; the recoverable resources of natural gas are at least as large as those of crude oil; the technology for synthetic methane production is more advanced and economic than that for other synfuels; and synthetic pipeline gas produced from coal can compete with coal-based electricity. Gas can play a pivotal role in achieving the goal of rapid substitution of coal for less abundant energy sources. For this role to be accomplished, a goal of a total pipeline-quality gas supply of at least 30 trillion ft^3 in the year 2000 is needed. Such a high-gas-use scenario would require full development of natural gas sources, gasification plants, and LNG imports. A plan for maximizing gas supply is outlined. (DLC)

OIL SHALES AND TAR SANDS

REFER ALSO TO CITATION(S) 35346

HYDROGEN AND SYNTHETIC FUELS

35392 (NP—23078) **National Gas Survey. Regulatory aspects of substitute gas.** (Supply-Technical Advisory Task Force on the Regulatory Aspects of Substitute Gas (USA)). Dec 1976. 341p. Power Commission, Washington, DC.

Report to the Federal Power Commission.

An updated comprehensive analysis of the future energy situation in the U.S. is presented. The future course of the natural gas industry and its impact on consumers and on the economy are emphasized. Sections are included on FPC and related regulation, other federal regulation, other regulations, and factors that suggest need for changes in laws and regulations. A number of appendixes are included containing information on state and local regulations. (JRD)

ELECTRIC POWER

REFER ALSO TO CITATION(S) 35459

35393 (EPRI-EA—584(Vol.1)) **Long-term residential load forecasting. Final report.** Granger, C.W.J.; Engle, R.F.; Ramanathan, R.; Andersen, A. (California Univ., San Diego, La Jolla (USA). Dept. of Economics; Econometric Research Associates, Del Mar, Calif. (USA)). Feb 1978. 86p. Dep. NTIS, PC A05/MF A01.

The main objective of this study was to isolate and evaluate the importance of various factors, many of which are household characteristics and weather conditions, that determine the demand for electricity at different times of day. A second purpose was to investigate one of the factors in detail, namely, prices, which was feasible because half of the households in the sample were subjected to time-of-day pricing. Substantial differences between the load curves of the experimental and control groups were found. House-

holds in the experimental group significantly decreased electricity usage when its price was high, the consumption being shifted partly into the early morning hours but more heavily into the evening. The importance of certain appliances in shifting the load curve is also clearly brought out. For example, households with a dishwasher or electric heating appeared to change the timing of use of these appliances under peak-load pricing. Other appliances were also important in determining the load curve for both groups. Swimming pool pumps and air conditioning, for instance, were important determinants in the summer, whereas in the winter, electric heating and dishwashers substantially increased consumption levels.

35394 (NP—22846) **Continuing California drought: an assessment of its effect on past and future energy productiou.** (California Energy Resources Conservation and Development Commission, Sacramento (USA)). Oct 1977. 24p. Energy Resources Conservation and Development Commission, Sacramento.

Portions of document are illegible.

The two successive dry years have severely impacted California's electrical utilities, and have caused them to make some major operating changes in order to provide adequate supplies of energy to meet their customer's demands. The following information describes the impact that two years of drought has had on the generating capabilities of the electric utilities in California, the contingency measures that have been taken, the minor events which have occasionally resulted in unusually low electrical reserve capacity margins, and what can be expected during 1978, should the drought continue. The staff of the Energy Commission conclude that by treating the entire state as a whole rather than by individual service areas, doing everything possible to maximize generation, and facilitating the transfer of power to areas of greatest need, that the State of California can withstand the threat of rolling blackouts, under the adverse conditions, without undue loss of income or substantial threat to the public health or safety. A continued drought will severely test the resources of the state's electrical utilities, and unusually high forced outage levels could conceivable create situations where occasional preplanned outages could result. However, increased conservation practices, proper advanced planning, complete cooperation between all utilities, and the maximum utilization of all generation resources, as recommended, should create a manageable situation in 1978.

35395 (TID—28112) **National Electric Rate Book. Louisiana.** (Federal Power Commission, Washington, D.C. (USA)). Jul 1977. 22p. Dep. NTIS, PC A02/MF A01.

Rate schedules for electric service in communities of 2,500 population or more: residential, commercial, and industrial services.

35396 (TID—28113) **National Electric Rate Book. Maine.** (Federal Power Commission, Washington, D.C. (USA)). Aug 1977. 10p. Dep. NTIS, PC A02/MF A01.

Rate schedules for electric service in communities of 2,500 population or more: residential, commercial, and industrial services.

35397 (TID—28114) **National Electric Rate Book. Missouri.** (Federal Power Commission, Washington, D.C. (USA)). Jul 1977. 34p. NTIS, MF A01.

Rate schedules for electric service in communities of 2,500 population or more: residential, commercial, and industrial services. Portions of document are illegible.

35398 (TID—28115) **National Electric Rate Book. Montana.** (Federal Power Commission, Washington, D.C. (USA)). Jun 1977. 6p. Dep. NTIS, PC A02/MF A01.

Rate schedules for electric service in communities of 2,500 population or more: residential, commercial, and industrial services.

35399 (TID—28116) **National Electric Rate Book. Oregon.** (Federal Power Commission, Washington, D.C. (USA)). Mar 1977. 10p. Dep. NTIS, PC A02/MF A01.

Rate schedules for electric service in communities of 2,500 population or more: residential, commercial, and industrial services.

35400 (TID—28117) **National Electric Rate Book. Rhode Island.** (Federal Power Commission, Washington, D.C. (USA)). Aug 1977. 6p. Dep. NTIS, PC A02/MF A01.

Rate schedules for electric service in communities of 2,500 population or more: residential, commercial, and industrial services.

35401 (TID—28118) **National Electric Rate Book. Delaware.** (Federal Power Commission, Washington, D.C. (USA)). Aug 1977. 7p. NTIS, MF A01.

Rate schedules for electric service in communities of 2,500 population or more: residential, commercial, and industrial services. Portions of document are illegible.

35402 (TID—28119) **National Electric Rate Book. Arizona.** (Federal Power Commission, Washington, D.C. (USA)). Aug 1977. 9p. NTIS, MF A01.

Rate schedules for electric service in communities of 2,500 population or more: residential, commercial, and industrial services. Portions of document are illegible.

35403 (TID—28120) **National Electric Rate Book. Arkansas.** (Federal Power Commission, Washington, D.C. (USA)). Sep 1977. 17p. NTIS, MF A01.

Rate schedules for electric service in communities of 2,500 population or more: residential, commercial, and industrial services. Portions of document are illegible.

35404 (TID—28121) **National Electric Rate Book. Colorado.** (Federal Power Commission, Washington, D.C. (USA)). Jun 1977. 14p. Dep. NTIS, PC A02/MF A01.

Rate schedules for electric service in communities of 2,500 population or more: residential, commercial, and industrial services.

35405 (TID—28122) **National Electric Rate Book. Connecticut.** (Federal Power Commission, Washington, D.C. (USA)). Aug 1977. 8p. NTIS, MF A01.

Rate schedules for electric service in communities of 2,500 population or more: residential, commercial, and industrial services. Portions of document are illegible.

35406 (TID—28124) **National Electric Rate Book. Hawaii.** (Federal Power Commission, Washington, D.C. (USA)). Jul 1977. 5p. NTIS, MF A01.

Rate schedules for electric service in communities of 2,500 population or more: residential, commercial, and industrial services. Portions of document are illegible.

35407 (TID—28125) **National Electric Rate Book. Kansas.** (Federal Power Commission, Washington, D.C. (USA)). Jun 1977. 27p. NTIS, MF A01.

Rate schedules for electric service in communities of 2,500 population or more: residential, commercial, and industrial services. Portions of document are illegible.

35408 **Tennessee Valley Authority power annual report: 77.** Chattanooga; Tennessee Valley Authority (1977). 44p.

An energy conservation program at TVA to assist the national research and development effort was implemented, particularly with the Home Insulation Program. Potential savings from this program include 1.25 billion kWh and almost $25 million in operating costs annually. Sales of 122 billion kWh were 12 percent more than sales for the preceding fiscal year. Peak loads were very high because of the weather, exceeding 23 million kW in winter--14 percent higher than the preceding fiscal year--and 21 million in summer. Units 1 and 2 at Browns Ferry Nuclear Plant resumed operation and unit 3 began initial operation. The plant contributed 20 billion kWh, or 16 percent of system generation. Revenues were $1.967 billion, an increase of 16 percent from the previous fiscal year primarily because of the increased use of electricity. The $54 million scrubber for Widows Creek unit 8 began test operation late in the year. The cost of coal burned in TVA plants continued to increase, reaching $21 per ton. That increase, however, was offset by the much lower cost of nuclear fuel at Browns Ferry. The system-wide average fuel cost of 8.9 mills per kWh was about the same as in the preceding fiscal year; fuel and related costs took 52 cents of every revenue dollar. Newly structured wholesale and resale rate schedules are discussed. Average TVA revenues showed little change in 1977. Power proceeds available for reinvestment in the power system from the year's operations total $62 million. This amount supplemented a net increase in borrowings of $995 million. TVA continued its discussions with states and the Environmental Protection Agency to find an acceptable plan for complying with limitations of SO_2 emissions. Work continued on facilities needed to meet clean air standards, and agreements were negotiated for several large new supplies of coal to help meet these standards.

CONSUMPTION AND UTILIZATION

35409 **Energy survey in the New Zealand dairy industry.** Vickers, V.T.; Shannon, D.V. (New Zealand Dairy Research Inst., Palmerston North). *N.Z. Energy J.;* **50**: No. 12, 191-197(25 Dec 1977).

An in-depth report on energy consumption in the New Zealand dairy industry for 1974—75 shows that a reduction in fuel consumption per unit of production has occurred when compared with two previous surveys (1954—55 and 1964—65). The increase in thermal efficiency of dairy processing was due mainly to the use of hot water heating systems in milk-treatment stations, the increased capacity of butter and cheese factories, increased thermal efficiency in skim milk drying and casein manufacture, increased efficiency in boiler plants, and higher drying air temperature achieved with the use of indirect oil- and gas-fired air heaters and liquid-phase air heating systems. Total energy consumed by the industry by type is

tabulated. Recommendations to the industry following the survey are listed. (MCW)

35410 Microeconomics and the demand for space heating. Fisk, D.J. (Building Research Establishment, Watford, Eng.). *Energy (Oxford);* **2**: No. 4, 391-405(Dec 1977).

The techniques of economic utility theory are combined with the technical equations for heat loss from a dwelling to give insight into the variation of consumer demand for space heating. A theoretical relationship is established between the performance of the occupied dwelling as the external temperature falls and the short-run income elasticity of energy demand. The analysis is applied to studies of UK heating practice in the 1950s and the implied indifference map for thermal comfort deduced. This indifference map is found to show a considerable economic propensity to absorb some of the potential savings from energy conservation measurements in higher internal temperatures. The effect found is sufficiently large to have consequences for future energy planning if it were still present in the UK domestic sector. The analysis highlights a number of points that should aid the interpretation of field experiments on domestic energy consumption. In particular, it is shown that unless great care is taken to separate out the technical and economic origins of internal temperature variation, the results of field studies on the effectiveness of conservation techniques may only be of shortlived value.

SOLAR

REFER ALSO TO CITATION(S) 34733, 34737

GEOTHERMAL

REFER ALSO TO CITATION(S) 34767, 34782, 34783

ENERGY CONVERSION

35411 Ferroelectricity in polyvinylidene fluoride. Kepler, R.G.; Anderson, R.A. (Sandia Laboratories, Albuquerque, New Mexico 87115). *J. Appl. Phys.;* **49**: No. 3, 1232-1235(Mar 1978).

Changes induced in the orientation of the axes of crystallites in thin films of polyvinylidene fluoride by the application of 6×10^7 V/m at 100 °C for 1/2 h have been observed. The changes were observed by measuring the intensity of x rays diffracted from the film as a function of the orientation of the film relative to the diffracting x-ray beam. A simple model calculation shows that the results are consistent with the assumption that the changes are induced by the interaction of the applied electric field with the dipole moments of the polyvinylidene fluoride molecules. The model uses the fact that the orthorhombic symmetry of the unit cell results from a small distortion of a hexagonal primitive lattice, the distortion being a 1% decrease in the separation between molecules in the direction of the dipole moments. This model is consistent with the assumption that polyvinylidene fluoride is ferroelectric.

MHD GENERATORS

DESIGN AND DEVELOPMENT

35412 (FE—1542-1) Annual report on the MHD high performance demonstration experiment, November 15, 1973—April 30, 1975. Garrison, G.W.; Schmidt, H.J.; Welch, N.E.; Brogan, T.R.; Hill, J.A.; Marston, P.G.; Hay, R.D.; Langton, W.G. (ARO, Inc., Arnold Air Force Station, Tenn. (USA); MEPPSCO, Inc., Boston, Mass. (USA); MEA, Inc., Cambridge, Mass. (USA)). Jul 1975. Contract EX-76-A-01-1542. 182p. Dep. NTIS, PC A09/MF A01.

The successful application of magnetohydrodynamics (MHD) for commercial, coal-fired, base-load power generation requires that the MHD generator have an energy extraction ratio of approximately 0.20 with a turbine efficiency of 70 percent. There is a significant gap between this required performance and the generator performance which has been achieved to date. The commercial MHD concept is critically dependent upon the generator achieving this required performance, and it is therefore essential that the achievability of this performance be demonstrated. Of equal importance, the generator channel configuration and operating conditions which are necessary in order to achieve the required performance can be determined while accomplishing the performance demonstration. Several possible options for carrying out an experiment meeting the objectives of the performance demonstration recommended by OCR Report No. 71 were considered and are reviewed in AEDC-TR-73-115. It was concluded that a definitive and favorable demonstration is feasible using the existing LORHO MHD facility at the AEDC with a modified magnet and a new high performance generator channel. The experiment will not only demonstrate performance but also will be of a size which will allow scaling of the experimental results to the full-scale generator with reasonable confidence. The AEDC has been under contract to the Office of Coal Research, Department of Interior, since December 1973 to renovate, modify, and improve the LORHO facility to conduct an MHD performance demonstration experiment. This is the first annual status report on the facility modifications and on the design and fabrication of the requisite new hardware.

35413 Technology and economics of MHD power generation. Ramanna, R. *Indian East. Eng.;* **118**: No. 12, 571-573, 603(Dec 1976).

A slightly condensed version of the 13th Mysore Engineer's Association Commemoration Lecture presented at Bangalore on November 6, 1976, by the director of Bhabha Atomic Research Centre, Bombay, is given. The importance of MHD power generation and its economic aspects with respect to India are discussed.

DUCT ENGINEERING AND FLUID DYNAMICS

35414 Effects of lead wire position along resistive electrode on current distribution in Faraday-type MHD duct. Hattori, Y.; Jayakumar, R.; Yoshikawa, K. (Kyoto Univ., Uji (Japan). Inst. of Atomic Energy). *J. Nucl. Sci. Technol. (Tokyo);* **14**: No. 4, 247-256(Apr 1977).

Effects of the lead wire position along the resistive electrodes on the current distribution in a segmented Faraday-type MHD duct when the resistivity of electrodes is larger than the optimal one are investigated. Detailed two-dimensional calculations for current distributions for flat-shaped resistive electrodes indicate that the highly resistive flat electrode with a lead wire placed away from one end can give a substantially uniform current distribution and reduce the Hall electric field at the electrode-insulator interfaces. Also it is shown that the internal resistance due to resistive electrodes for relatively large Hall parameters may be still comparable with the internal resistance for conductive electrodes when the lead wire is shifted to the appropriate position on the resistive electrode.

THERMOELECTRIC GENERATORS

DESIGN AND DEVELOPMENT

35415 Tubular thermoelectric module. Markman, M.A.; Simanovskii, L.M.; Yurkevich, I.R.; Kolomoets, N.V.; Kamensky, V.T.; Matskov, I.M.; Maximov, S.I. US Patent 4,056,406. 1 Nov 1977. Filed date 15 Jan 1975. 4p.

A tubular thermoelectric module used primarily as a part of thermoelectric generators is described comprising an inner thermal conductor with circular thermopiles embracing the inner thermal conductor, and with strips serving to interconnect the thermopiles; an outer thermal conductor in the form of several sealed taper clamps, each embracing a circular thermopile; and electric insulation units which insulate one thermopile from another and from the inner and outer thermal conductors.

PERFORMANCE AND TESTING

REFER ALSO TO CITATION(S) 34679

DESIGN AND DEVELOPMENT

REFER ALSO TO CITATION(S) 34683

FUEL CELLS

DESIGN AND DEVELOPMENT

35416 Fuel cells and methods of operating them. Elzinga, E.R. (to Exxon Research and Engineering Co.). US Patent 4,040,435. 9 Aug 1977. Priority date 18 Nov 1974, United Kingdom of Great Britain and Northern Ireland (UK). 6p.

A fuel cell wherein the electrolyte comprises a volatilizable solvent and a solute whose solubility in the solvent varies with electrolyte temperature can be operated by increasing or decreasing the amount of solvent relative to the amount of solute as the solubility of the latter in the solvent respectively decreases or increases due to variations in the temperatures of the electrolyte in the cell or cell system. A suitable fuel cell has an anode compartment supplied by a fuel and uses an electrolyte comprising an aqueous solution of at least one salt and has a cathode compartment supplied with a gas containing molecular oxygen, wherein the electrolyte is conveyed from a first container and returned to the latter after passing through said anode compartment and comprises a condenser suitable for condensing a predetermined quantity of the water vapor present in the gases emerging from the cathode compartment and a second container receiving condensed water from said condenser,

this latter container communicating with said first container by means of an overflow and a valve. 9 claims, 1 drawing.

MATERIALS, COMPONENTS, AND AUXILIARIES

35417 Apparatus for controlling the electrolyte concentration of fuel cell batteries. Jaeger, P. (to Siemens AG). US Patent 4,061,838. 6 Dec 1977. Priority date 29 Apr 1975, German, Federal Republic of (F.R. Germany). 4p.

Apparatus for controlling the electrolyte level and electrolyte concentration of fuel cell batteries is described, which comprises an electrolyte vessel and a tube, open on both sides and having an overflow at a distance h from its lower end, with its lower end immersed in the electrolyte vessel and the reaction water depleted in the fuel cell battery supplied to its upper end, in which apparatus h is selected such that $h = l \cdot \gamma_1/\gamma_0$ where l is the immersion depth of the tube in the electrolyte vessel, γ_1 the density of the electrolytic liquid and γ_0 the density of the depleted reaction water.

35418 Method of fabricating a fuel cell electrode. Breault, R.D.; Harding, R.P.; Kemp, F.S. (to United Technologies Corp.). US Patent 4,043,933. 23 Aug 1977. Filed date 15 Jun 1976. 6p.

A method of fabricating a fuel cell electrode is described comprising an electrocatalyst and binder wherein the colloidal chemistry of the aqueous catalyst and the binder suspension are controlled during the deposition of the catalyst/binder onto an electrode substrate. Control is by addition of acids, bases, or salts to an aqueous suspension of binder and catalyst to adjust the pH to within certain ranges to form a flocculate. The flocculate is then fabricated into an electrode. The catalyst/binder distribution within the electrode and electrochemical performance, including decay characteristics, of the electrode are improved.

35419 Finely particulated colloidal platinum compound and sol for producing the same, and method of preparation of fuel cell electrodes and the like employing the same. Petrow, H.G.; Allen, R.J. (to Prototech Co.). US Patent 4,044,193. 23 Aug 1977. Filed date 20 Dec 1974. 16p.

This disclosure deals with novel very fine, particulated colloidal platinum of the 15-25 Angstrom size range of unusual catalytic activity and particularly adapted for adsorption or other deposition upon carbon for use as fuel cell catalytic electrodes and the like and produced from platinum colloids and sols including complex platinum sulfite compounds and sols derived therefrom.

ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

REFER ALSO TO CITATION(S) 35372

35420 (EPRI-EM—313-SR, pp 2.22-2.31(Vol.I)) **Economic analysis of energy demand and conservation.** Crow, R.T. 1976.

From EPRI workshop on technologies for conservation and efficient utilization of electric energy; San Diego, CA, USA (26 Jul 1976).

In Proceedings of an EPRI workshop on technologies for conservation and efficient utilization of electric energy. Volume I. Executive summary; Volume II. Working papers.

The major issues concerning the relationship of economic analysis to problems of energy utilization and conservation are presented and discussed. It is concluded that the economic analysis of energy demand and conservation should be approached both by form of energy and by economic sector. It appears that economic theory and techniques of statistical inference are particularly important in developing the practical representation of energy demand behavior for long-run forecasting purposes. Conservation efforts will be reflected in policies deliberately designed to reduce the amount or type of energy consumption and by technological change which will attempt to increase either the physical efficiency of energy usage or enable switching between high price and lower priced energy sources. Of utmost importance is the realization that energy demand and conservation is not separable from the rest of the economy and society. It should be studied in a systems context in order to assess the impacts of various technologies and policy proposals. This must be done in order to avoid "cures" to the problem of energy that would be worse than the disease itself.

35421 (EPRI-EM—313-SR, pp 4.43-4.49(Vol.II)) **Implications of more efficient energy use.** Males, R. 1976.

From EPRI workshop on technologies for conservation and efficient utilization of electric energy; San Diego, CA, USA (26 Jul 1976).

In Proceedings of an EPRI workshop on technologies for conservation and efficient utilization of electric energy. Volume I. Executive summary; Volume II. Working papers.

Five topics are briefly reviewed. These are: definition of conservation or efficiency; the role of energy in economy; measures of efficiency; implications of efficient energy use; and national significance of energy use.

35422 (EPRI-EM—313-SR, pp 5.1-5.20(Vol.II)) **Potential R and D opportunities.** Smith, C.B. 1976.

From EPRI workshop on technologies for conservation and efficient utilization of electric energy; San Diego, CA, USA (26 Jul 1976).

In Proceedings of an EPRI workshop on technologies for conservation and efficient utilization of electric energy. Volume I. Executive summary; Volume II. Working papers.

R and D priorities, evaluation criteria, and some proposed R and D areas for the electric Power Research Institute are described. The list of R and D opportunities presented is not all-inclusive and in fact has been directed at generic needs more than specific projects. Nationwide, it has been estimated that improved use efficiency can save 17 to 34% of U.S. electricity use over the 25-year period 1975 to 2000, compared to an "historical growth" extrapolation. Case studies and current research indicate that savings of 10 to 30% are possible in the industrial and residential/commercial sectors, often with no capital expense. Most of the "easy" (no capital investment) savings have already been seized by industry. Thus, it appears that further gains, to bring the national average beyond the 10 to 15% level, will depend on capital investment and new or improved technology. These are interrelated. If we are innovative and creative, we can conserve scarce capiital resources at the same time we conserve fuel and energy. Without the benefit of R and D achievements in the energy field, we can expect substantial capital investments and higher operating costs as we find expensive substitutes for scarce energy forms and meet ever-increasing energy prices.

BUILDINGS

REFER ALSO TO CITATION(S) 34735, 34871, 35465, 35466, 35479

35423 (EPRI-EM—313-SR, pp 2.8-2.17(Vol.I)) **Energy storage and heat pumps: lessons learned.** Pepper, J.W. 1976.

From EPRI workshop on technologies for conservation and efficient utilization of electric energy; San Diego, CA, USA (26 Jul 1976).

In Proceedings of an EPRI workshop on technologies for conservation and efficient utilization of electric energy. Volume I. Executive summary; Volume II. Working papers.

Three projects aimed at energy conservation through the use of heat pumps with improved performance characteristics are discussed. (LCL)

35424 (EPRI-EM—313-SR, pp 1.19-1.30(Vol.II)) **Engineering aspects of efficient electric energy end-use.** Snyder, W. 1976.

From EPRI workshop on technologies for conservation and efficient utilization of electric energy; San Diego, CA, USA (26 Jul 1976).

In Proceedings of an EPRI workshop on technologies for conservation and efficient utilization of electric energy. Volume I. Executive summary; Volume II. Working papers.

Power demand for the industrial, commercial, and residential sectors of the U.S. economy and methods for improving the efficiency of specific end uses of electric power such as for space heating and air conditioning, appliances, and industrial equipment are discussed. Recommendations are made for compiling reliable data on power demand and for research and development programs which would improve electric energy end use efficiency. (LCL)

35425 (EPRI-EM—313-SR, pp 5.78-5.82(Vol.II)) **Designer's need for research information.** Spielvogel, L.G. 1976.

From EPRI workshop on technologies for conservation and efficient utilization of electric energy; San Diego, CA, USA (26 Jul 1976).

In Proceedings of an EPRI workshop on technologies for conservation and efficient utilization of electric energy. Volume I. Executive summary; Volume II. Working papers.

The type of information needed by designers to improve energy conservation in buildings and how research programs will provide such information are discussed. Research on design methods for heating-ventilating and air conditioning systems and for predicting the energy needs of buildings are recommended. (LCL)

35426 (EPRI-EM—313-SR, pp 5.83-5.92(Vol.II)) **Utility experience and R and D needs in HVAC systems.** Lovvorn, N.C. 1976.

From EPRI workshop on technologies for conservation and efficient utilization of electric energy; San Diego, CA, USA (26 Jul 1976).

In Proceedings of an EPRI workshop on technologies for conservation and efficient utilization of electric energy. Volume I. Executive summary; Volume II. Working papers.

The experience of the Alabama Power Co. in encouraging its customers to make the wisest use of electric power is related. Electric power conservation in homes has been achieved by improved thermal insulation, design of homes with fewer heat loss areas, use of improved efficiency heating and cooling equipment including heat pumps, and heat recovery water heaters. Research on all these subjects is recommended. (LCL)

35427 Heat recovery and energy conservation. Applegate, G. *N.Z. Energy J.;* **51**: No. 1, 5-6(25 Jan 1978).

The energy conservation potential of using waste heat in the heating and cooling of buildings is described, and heat recovery by means of straightforward rotary air-to-air heat regenerators, i.e., heat wheels, is discussed. Information is included on the operation, performance, economics, and utilization of heat wheels. (LCL)

35428 Role of refrigeration in energy conservation. Perry, E.J. (W.S. Atkins and Partners, Epsom, Surrey, Engl). *ASHRAE J.;* **19**: No. 12, 17-21(Dec 1977).

An energy study for a building complex is described covering heating, cooling and power generation duties using computer modelling techniques. The study shows that many variations of plant operation, such as different levels of peak lopping and base load operation, can be simulated and the results readily obtained so as to determine the best electrical expenses. Seven heating options and eight air conditioning options incorporating either vapor compression or absorption plant were analyzed.

35429 Low temperature energy carrying apparatus and method. Yamada, T.; Mori, S.; Kato, K.; Arai, Y.; Sakitani, K. (to Daikin Kogyo Co., Ltd.). US Patent 4,051,888. 4 Oct 1977. Priority date 7 Jul 1973, Japan. 16p.

The invention relates to a low temperature energy carrying apparatus and method adapted for central cooling which comprises a hydrate circulating system for a liquid hydrate agent and hydrate crystals incorporated with a conventionally designed water circulating system. In the hydrate circulating system, the hydrate crystals are fed to the users side together with cooled water and decomposed therein into hydrate agent and cooled water absorbing the latent heat of decomposition. Therefore, the temperature of the cooled water during transport thereof to the users side is stabilized and in addition to the sensible heat of the cooled water the latent heat of the hydrate crystals can be utilized in the users side, thereby improving cooling effect in the users side. Also, the hydrate circulating system is adapted to use a hydrate agent in the liquid phase area which allows the operation of the system to be stabilized.

35430 I. Computer as a design tool for energy conservation. Newton, A. *RIBA J.;* **84**: No. 10, 438-439(Oct 1977).

The value of the computer as a design aid has been a controversial subject since it was first introduced to the architectural profession. Two articles are presented which explore different aspects of computer—aided design. One supports the use of computers for the analysis of energy conservation in buildings. The other questions the value of computers in the design process and examines its effects on the practising architect.

35431 Farm heat pump recovers heat from dung. Eichenhorst, H.; Kimpenhaus, W. (Rheinisch-Westfael Elektrizitaetswerk, Essen, Ger). *Elektrowaerme Int., Ed. A;* **35**: No. 5, 290-294(Sep 1977). (In German).

Dung offers numerous bacteria and fungi an excellent habitat owing to its large store of organic substances. The reactions release heat which can be withdrawn from the dung heap and utilized. The article describes the design and operation of a heat pump recovering heat from dung. The results of measurements made in experimental operation are mentioned. These findings furnish information as to the conditions under which farm wastes can be used as a source of heat.

35432 Electric properties of heat-insulating materials for backfilled district heating pipelines. Zavertkin, I.A. (All-Union Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 8, 50-53(Aug 1977). (In Russian).

Electric resistance of heat insulating materials used in backfilled district heating pipelines is investigated, not as usually in their dry state, but in a moist state, closer to their real conditions of operation. It is found that specific volumetric electric resistance of all the heat simulating materials considered drops significantly after wetting, especially at the initial stage, with a low moisture content. Experimental results show that hydrophilic materials do not ensure the required electric resistance even with slight wetting (1-3% of mass), which favors development of external corrosion of pipelines. Minimum permissible values of electric resistance of hydrophobic powders (asphaltite, hydropholized chalk, etc.) are attained for high moisture contents (8-10% of mass), which results in a more reliable protection of pipelines from corrosion.

35433 Energy saving in lighting. Narisada, K. (Matsushita Electr Ind Co, Ltd, Osaka, Jpn). *Natl. Tech. Rep. (Matsushita Electr. Ind. Co., Osaka);* **23**: No. 4, 535-539(Aug 1977).

The disadvantage of the reduction of lighting levels as a concept of energy saving in lighting is analyzed. It is estimated that the energy saving to be gained by reducing levels of lighting might, at maximum, be on the order of only 0.5% of total consumption of primary energy. Such savings might easily be offset by possible increased losses of natural resources and energy in factories, offices, etc. as a result of a deterioration in the visual performance of workers caused by the reduced level of lighting. The best way to save energy in lighting without such increased losses is to improve the efficiency of lighting systems by utilizing advanced lighting equipment and lighting techniques, in order to thereby decrease energy consumption required for lighting, while still maintaining the necessary level of lighting recommended internationally by the Commission Internationale de l'Eclairage. In this connection, the importance of conducting investigations concerning visual performance in relation to lighting is stressed. Reference to English-language sources are in English. 7 refs. Japanese.

35434 New high-pressure sodium lamps with low-ignition voltage. Saito, N.; Yamazaki, H.; Akutsu, H. (Matsushita Electron Corp, Jpn). *Natl. Tech. Rep. (Matsushita Electr. Ind. Co., Osaka);* **23**: No. 4, 552-561(Aug 1977).

The high-pressure sodium lamp features luminous efficacy which is twice as high as high-pressure mercury lamps. However, because the sodium lamp requires a high voltage of more than 2,000 V for its ignition, it has not become popular. The authors attempted to lower the ignition voltage so as to eliminate an additional ignitor, and succeeded through development of a new ignition method by using neon-argon penning gas and, to assist ignition, a coil around the discharge tube. The new lamp operates on a single-choke ballast, without an ignitor, which has made it possible to install the new lamp in existing high-pressure mercury sockets with only a simple rearrangement of the ballasts. The low-voltage ignition of the lamp assures high reliability to customers, even with their existing wiring. Thus the new lamp is expected to make great contributions to worldwide energy-saving goals, not only in new lighting installations, but also through utilizing existing lighting facilities. Illustrations, diagrams, and graphs include English captions. References to English-language sources are in English. 17 refs. Japanese.

35435 Case for increased insulation of domestic hot-water cylinders. Elkis, W.J. *N.Z. Energy J.;* **50**: No. 5, 64-66(25 May 1977).

The level of insulation specified has been unchanged since 1949 and increasing emphasis on energy conservation and rapid price increases for energy now warrant a close review of that level. It should be tripled or even quadrupled. Available insulation materials and optimum thickness versus initial costs and power costs are discussed.

35436 Short summary of present applications and hopes for the development of heat pumps in france. Robin, A. (Electr de Fr). *Rev. Energ.;* **28**: No. 296, 176-186(1977). (In French).

Four categories used in space heating are described: air-air, air-water, water-air, and water-water heat pumps. The number of new dwellings in France equipped with heat pumps has moved from 900 at the beginning of 1975, to 1800 in 1976 and then to 3100 at the beginning of 1977 (of which 2800 collective dwellings). In the tertiary sector at the beginning of 1977, more than 700 heat pumps were in service: 150 in office buildings, 350 in stores and 200 in small business locations. In the industrial sector the heat pump did not really start to be used industrially until the beginning of the 1970's with wood-drying by dehumidification of air. More than 1000 installations are currently operating in France on this principle. Similar driers have been developed for the drying of skins and of port-meat products. Application of heat pumps in other industries in France is growing.

35437 Life and luminous flux of halogen incandescent lamps related to filament temperature, pressure and ch_2br_2 content. de Bie, J.R.; Ponsioen, J.C.M.A. (Philips' Gloeilampenfabr, Eindhoven, Neth). *Light Res. Technol.;* **9**: No. 3, 141-150(1977).

An experimental study has been made of 20 V, 100 W halogen incandescent lamps using different filling pressures for the halogen additive (0.25-16 torr CH$sub 2$Br$sub 2$) and the inert gas Kr (4-16 atm.), and burning at two voltages. The maximum luminous flux and life were found for lamps with halogen filling pressures of 1-4 torr CH$sub 2$Br$sub 2$. Lamps with low halogen filling pressures blacken. At high pressures, attack on the cold coil ends determines life. The blackening or nonblackening in general accords with the transport criterion derived from the solubility of tungsten in the gaseous phase. Halogen lamps with properly operating transport cycles fail due to a local temperature increase leading to burning-through of the filament. The experimentally found relation between life, filament temperature and filling pressure agrees approximately with the theory of the radial transport of tungsten in these halogen lamps. A correlation was found between lamp life and the temperature increase of the hot spot.

35438 Characterization of building infiltration by the tracer-dilution method. Lagus, P.L. (Systems, Science and Software, La-Jolla, CA). *Energy (Oxford);* **2**: 461-464(1977).

Air infiltration is an important factor in the total energy budget of a structure. It is also a significant parameter in indoor-outdoor air pollution relationships. Air infiltration cannot be reliably calculated but must be measured in a structure of interest. The tracer-dilution method is a useful technique to determine infiltration rates. This technique entails measurement of the logarithmic dilution rate of a tracer gas concentration with respect to time.

35439 Lowering operation costs by energy recovery. Wegener, W.; Hausmann, H.; Hausmann, K.H. *Sport Baeder Freizeit-Bauten ;* **16**: No. 2, 176-192(1976). (In German).

Heat recovery and the heat sources available as well as possible applications of the heat recovered are discussed. Groundwater, shower water and waste air are considered as energy sources. Energy recovery by means of finned-tube systems and the heat pump, and economic aspects of the techniques are described.

35440 Optimal design of heat insulation for air-conditioned buildings. Galustova, L.A.; Peker, Ya.D.; Momot, A.I. *Appl. Solar Energy (USSR) (Engl. Transl.);* **12**: No. 4, 48-52(1976).

Translated from Geliotekhnika; 12: No. 4, 63-69(1976).

One method for sequential analysis of variants with directed examination is described. The integrated optimization of heat insulation for an air-conditioned building with seven variable parameters is considered. Directed examination of the variables is used to find the objective function (the specific adjusted costs) in significantly fewer steps (130 as against 2304); the objective function may be computed for each specific case.

35441 Thermal calculations for various building sun screens. Gul'karov, E.S. *Appl. Solar Energy (USSR) (Engl. Transl.);* **12**: No. 4, 53-55(1976).

Translated from Geliotekhnika; 12: No. 4, 70-73(1976).

A solution is given to the Fourier heat-conduction equation with allowance in the boundary conditions for fluctuations in thermal effects with application to the design of building heat-protection elements. Sample calculations are given.

RESIDENTIAL BUILDINGS

REFER ALSO TO CITATION(S) 35353, 35393

35442 (CONF-7510172—P2, pp 1437-1446) **Report on the use of thermal scanner data in an operational program for monitoring apparent rooftop temperatures.** Bjorklund, J. (CENGAS, Sioux Falls, SD); Schmer, F.A.; Isakson, R.E. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

CENGAS, a division of Central Telephone and Utilities Corporation in cooperation with the Remote Sensing Institute, South Dakota State University, is using airborne thermal scanner data to monitor relative rooftop temperatures. Four Nebraska communities and one South Dakota community were surveyed by the Remote Sensing Institute for CENGAS. Thermal scanner data were converted to a film format and the resultant imagery has been successfully employed by CENGAS. The program places emphasis on heat losses resulting from inadequate home insulation, offers CENGAS customers the opportunity to observe a thermogram of their rooftop, and assists homeowners in evaluating insulation needs.

35443 (EPRI-EM—313-SR, pp 1.7-1.18(Vol.II)) **Physics of efficient energy end-use.** Ross, M. 1976.

From EPRI workshop on technologies for conservation and efficient utilization of electric energy; San Diego, CA, USA (26 Jul 1976).

In Proceedings of an EPRI workshop on technologies for conservation and efficient utilization of electric energy. Volume I. Executive summary; Volume II. Working papers.

The fuel consumption associated with any activity or process is obtained by multiplying two factors, i.e., the demand for a product and the specific energy or the energy required to provide each unit of the product. For example, the fuel used to drive an automobile is the number of miles driven times the specific energy. The specific energy in this case is the average number of gallons consumed per mile, the reciprocal of the familiar miles per gallon. The physics involved in determining the minimum fuel consumption for a particular task is discussed under the following topics: we consume "available work" not energy, survey of efficiency in the U.S. economy, and policy applications.

35444 (EPRI-EM—313-SR, pp 4.33-4.42(Vol.II)) **Conservation of resources through utility load control and peak shaving: practical implementation and implications for R and D.** Jack, C.F. 1976.

From EPRI workshop on technologies for conservation and efficient utilization of electric energy; San Diego, CA, USA (26 Jul 1976).

In Proceedings of an EPRI workshop on technologies for conservation and efficient utilization of electric energy. Volume I. Executive summary; Volume II. Working papers.

The practical experience of Buckeye Power, Inc. and other electrical utilities in shaving peak loads and some of the R and D implications involved are discussed. The design, operation, and installation of the load management system which uses a central computer to regulate 23,000 residential water heaters are described. Each radio switch control cost $90 installed or an average load management capital cost of about $64 per kW. Approximately 34,500 kW was the annual peak load reduction which equates to a net saving of $600,000. Less than 30 "cold water" complaints were received. This experience plus the potential of the centrally controlled management system to reduce loads instanteously during an emergency, make the system highy recommendable. (LCL)

35445 (EPRI-EM—313-SR, pp 5.44-5.47(Vol.II)) **R and D needs in residences.** Woodson, T.T. 1976.

From EPRI workshop on technologies for conservation and efficient utilization of electric energy; San Diego, CA, USA (26 Jul 1976).

In Proceedings of an EPRI workshop on technologies for conservation and efficient utilization of electric energy. Volume I. Executive summary; Volume II. Working papers.

Research and Development studies to achieve energy conservation in residences are suggested, and include research on basic equipment; materials; control systems for electric power load limiting and optimization; instruments for user measurement of energy consumption; use of integrated heat-power systems augmented by solar power, wind power, and fuel cells; and recycling of household appliances and waste materials. (LCL)

35446 New electric motor may be major energy saver. De Lesseps, E.H. *N.Z. Energy J.;* **51**: No. 1, 7-8(25 Jan 1978).

The operation and performance of an electric motor designed to operate close to its optimum work load at all times is discussed. This new motor design, which is particularly usable in home appliances, is claimed to save 10 percent in power demand and could save millions of dollars through energy conservation. (LCL)

35447 Energy and the profession. Burton, R.; O'Sullivan, P. *RIBA J.;* **84**: No. 10, 431-432(Oct 1977).

The role that the Royal Institute of British Architects (RIBA) should play in promoting energy conservation in buildings is commented on. The actions recommended include: conservation education for RIBA members; implementation of the Government energy policy for existing buildings; work toward establishing research programs on energy conservation in new buildings; and involvement in programs related to planning the most efficient means of energy production and transmission. (LCL)

35448 Modernization of a residence--an example of the planning task for an architect. Kriessbach, K.; Quanz, K.H. (Hauptberatungsstelle fuer Elektrizitaetsanwend, Frankfurt AM, Ger). *Elektrowaerme Int., Ed. A;* **35**: No. 5, 261-268(Sep 1977). (In German).

The modernization of a residential building involving structural changes and complete renewal of all sanitary and other installations are described in order to illustrate the intricacies of such an architectural task. Proceeding from an analysis and diagnosis of the structural condition of the building, the individual planning stages are described extending from the improvement of the layout, thermal insulation and noise suppression, to the choice of kitchen equipment, heating system, sanitary and finally the electric installations. Detailed suggestions for solutions are presented.

OFFICE BUILDINGS

35449 Comfortable physical environment and energy conservation. Satone, H. (Matsushiti Electr Ind Co, Ltd, Osaka, Jpn). *Natl. Tech. Rep. (Matsushita Electr. Ind. Co., Osaka);* **23**: No. 4, 604-615(Aug 1977).

First, the three basic aspects necessary for a comfortable working environment--lighting, climate and sound--are described. By adoption of thermal-integrated systems of lighting and air conditioning, not only can a more comfortable environment be maintained, but also electric power consumption can be reduced by about 10% of the cooling load. Physical environment and occupants' assessments were surveyed in several offices which had integration of lighting, air conditioning and acoustics. Almost all occupants were satisfied with above integrated physical environment, admitting a few problems to be solved. Illustrations, diagrams, graphs, and tabulations include English captions. References to English-language sources are in English.

COMMERCIAL AND INDUSTRIAL BUILDINGS

REFER ALSO TO CITATION(S) 35443

35450 (EPRI-EM—313-SR, pp 5.48-5.73(Vol.II)) **R and D for more efficient electricity use in the commercial sector.** Taussig, R. 1976.

From EPRI workshop on technologies for conservation and efficient utilization of electric energy; San Diego, CA, USA (26 Jul 1976).

In Proceedings of an EPRI workshop on technologies for conservation and efficient utilization of electric energy. Volume I. Executive summary; Volume II. Working papers.

R and D programs which will achieve electric power conservation in commercial buildings by improving the end-use efficiency of present electrical equipment and by introducing new technology are discussed. Electrical equipment for space heating, air conditioning, water heating, lighting systems, and electric motors are considered. Heat recovery systems and total energy systems are described. (LCL)

TRANSPORTATION

AIR AND AEROSPACE

REFER ALSO TO CITATION(S) 35352

RAILWAY

35451 **Fuel economy on railways.** Dandavate, M. *Indian East. Eng.;* **119**: No. 10, 485, 487, 489(Oct 1977).

A critical review is given of the significance of fuel economy on Indian Railways. Aspects of electrification, traction policy and measures necessary to effectively run Asia's largest railway system are considered.

LAND AND ROADWAY

35452 (CONF-7511129—, pp 365-393) **Remarks on energy saving opportunities in separation processes.** Noe, S.; Paret, G. (Snam Progetti, S. Donato Milanese, Italy). 1975.

From 159. international assembly of the European Federation of Chemical Engineering; Milan, Italy (10 Nov 1975).

In Energy saving in chemical processing.

The processes for separating liquid substances in the hydrocarbon processing industry are considered. In particular, the main routes, i.e., rectification and solvent extraction or related technologies, are compared and discussed. The fact that the hydrocarbon processing industry in the past has resorted to a solvent only in the case of "impossible" separation is pointed out. The opportunity of adopting a solvent for "non-impossible" separation is discussed and examples of the use of this technology are illustrated. The possibility of energy saving using a solvent also for certain cases where rectification is possible is discussed and illustrated by examples. The first example concerns the butadiene extraction process, the second the extraction of aromatics. In both cases the use of a solvent for the recovery of the product is demonstrated to be successful in saving both energy and money.

PIPELINE

REFER ALSO TO CITATION(S) 35501

INDUSTRY AND AGRICULTURE

REFER ALSO TO CITATION(S) 35424

35453 (CONF-7511129—) **Energy saving in chemical processing.** (Federazione delle Associazioni Scientifiche Tecniche, Milan (Italy)). 1975. 667p. (In English and Italian). Dep. NTIS (US Sales Only), PC A99/MF A01.

From 159. international assembly of the European Federation of Chemical Engineering; Milan, Italy (10 Nov 1975).

Twelve papers presented at the conference are included in this volume. A separate abstract was prepared for each paper. (LCL)

35454 (CONF-7511129—, pp 29-49) **Energy consumption assessment methods.** Sutherland, K.S. (Chemical Engineering Developments, London). 1975.

From 159. international assembly of the European Federation of Chemical Engineering; Milan, Italy (10 Nov 1975).

In Energy saving in chemical processing.

The why, what, and how-to aspects of energy audits for industrial plants, and the application of energy accounting methods to a chemical plant in order to assess energy conservation possibilities are discussed. (LCL)

35455 (CONF-7511129—, pp 105-170) **Role of the process designer in the evolution of a technology oriented toward energy conservation.** Cassarino, S. (CONSER, Rome); Riccardi, R. 1975.

From 159. international assembly of the European Federation of Chemical Engineering; Milan, Italy (10 Nov 1975).

In Energy saving in chemical processing.

The increase in energy costs has introduced new stringent boundaries to process engineering, involving the need for more and more advanced calculation techniques and a greater accountability on the part of the process designer for the purposes of a financially effective engineering work. The designing and optimization approaches tending to favor minimum investment decisions for the past are now subjected to a careful critical revision under the pressures of this new reality. The process designer can--through such revision process--bring a substantial contribution of his own to the development of a technology oriented toward energy conservation. In view of these considerations and on the basis of newly emerging trends, some examples are introduced to illustrate certain development opportunities in oil-refining and petrochemical industrial processes. Conventional designs covering a refining plant and an oil fractionating unit are compared in details in this review with alternative patterns to which new designing approaches are applied for the purposes of an optimized energy consumption.

35456 (CONF-7511129—, pp 221-251) **Rationalization of energy consumption in the chemical industry.** Gardella, U. (Montedison, Milan). 1975.

From 159. international assembly of the European Federation of Chemical Engineering; Milan, Italy (10 Nov 1975).

In Energy saving in chemical processing.

The rationalization of energy consumption, in the special case of the chemical industry, cannot be considered as accomplished by a simple saving in utilities. New facts on energy supplies, which now motivate a greater commitment to energy conservation, call for a different approach and open up fresh prospects, concern both the price and availability of energy sources. The sharp and abnormal jump in energy costs has at the same time increased practically all cost structures and hence the optimum economic balance attained through years of technological refinement and adaptation to situations that varied with reasonable graduality. It is therefore, the entire productive structure that today requires a complex technical-economic overhaul, aiming at reinstating optimum balances. The "availability" factor, understood as a contingent problem in relation to uncertainties of a political nature and to the trend of national monetary balances, as well as an absolute problem in a long-term perspective, demands in turn a decisive change of course, i.e., saving should now be pursued even if it is foreign to company profit, provided of course that it is not in conflict with the latter. Certain aspects of the problem in the above sense are reviewed and criteria for a rational approach to a gradual development of its solution through an organic classification of possible initiatives are suggested. An indication of the foreseeable average saving percentages on energy consumption for the different types of action considered, based on experience acquired with the major Italian chemical company, is included.

35457 (CONF-7511129—, pp 297-334) **Energy saving in refineries and petrochemical complexes.** Verde, L. (S.I.R., Milan). 1975.

From 159. international assembly of the European Federation of Chemical Engineering; Milan, Italy (10 Nov 1975).

In Energy saving in chemical processing.

Possible measures applicable in the design of refineries and petrochemical complexes, to effect energy savings were investigated. This was not limited to the single process unit problems, on the contrary the attention is mainly addressed to the identification of the interrelations between different units, emphasizing possible integrations. Particularly, the optimization of the pressure levels and number of the utility networks for steam distribution inside plant facilities, is considered, in order to maximize heat recovery in the process units, and electric power production in the central steam-power generation plant. A computer program of general application, based on profitability evaluation at various fuel oil prices and different project configurations, has been developed for these purposes. The general measures applicable within certain limits are then briefly examined. The task of the process engineer is discussed in the perspective of the "energy saving" goal.

35458 (EPRI-EM—313-SR) **Proceedings of an EPRI workshop on technologies for conservation and efficient utilization of electric energy. Volume I. Executive summary; Volume II. Working papers.** (Applied Nucleonics Co., Inc., Los Angeles, Calif. (USA)). 1976. 301p. (CONF-760768—). Dep. NTIS, PC A14/MF A01.

From EPRI workshop on technologies for conservation and efficient utilization of electric energy; San Diego, CA, USA (26 Jul 1976).

Twenty-seven papers on the R and D needs for efficient energy use as they affect the electric utility industry were presented at the meeting. A separate abstract was prepared for each paper. (LCL)

35459 (EPRI-EM—313-SR, pp 2.1-2.3(Vol.I)) **EPRI objectives in an energy end-use R and D program.** Kalhammer, F.R. 1976.

From EPRI workshop on technologies for conservation and efficient utilization of electric energy; San Diego, CA, USA (26 Jul 1976).

In Proceedings of an EPRI workshop on technologies for conservation and efficient utilization of electric energy. Volume I. Executive summary; Volume II. Working papers.

The Electric Power Research Institute's R and D programs for energy conservation seek to identify, develop,nd evaluate technologies which promote electric power conservation through the use of more efficient devices and systems; development of new uses of electric power to replace present uses of oil and natural gas; and more efficient power systems operation through load management. Specific programs for achieving these objectives are itemized. (LCL)

35460 (EPRI-EM—313-SR, pp 2.4-2.7(Vol.I)) **Energy conservation in the Energy Analysis and Environment Division: the demand and conservation program.** Crow, R.T. 1976.

From EPRI workshop on technologies for conservation and efficient utilization of electric energy; San Diego, CA, USA (26 Jul 1976).

In Proceedings of an EPRI workshop on technologies for conservation and efficient utilization of electric energy. Volume I. Executive summary; Volume II. Working papers.

The major objectives of the EPRI's power demand and conservation program are to improve energy demand forecasting methods and to reliably forecast demand for use in planning electric utiiities research and development. The subprograms of the power demand study are listed and briefly discussed. (LCL)

35461 (EPRI-EM—313-SR, pp 2.14-2.24(Vol.II)) **Technological and R and D opportunities for energy conservation and load management in electrolytic processes.** Meredith, R.E. 1976.

From EPRI workshop on technologies for conservation and efficient utilization of electric energy; San Diego, CA, USA (26 Jul 1976).

In Proceedings of an EPRI workshop on technologies for conservation and efficient utilization of electric energy. Volume I. Executive summary; Volume II. Working papers.

The feasibility of using electrochemical processes for electric load leveling on a seasonal basis is examined. Specifically, the electric energy requirements of the aluminum and chlorine industries are considered from the point of view of reducing the peak demands of electricity in the U.S. Both national and regional effects are considered. Models are presented which are both bounded and unbounded by industrial capacitiies.

35462 (EPRI-EM—313-SR, pp 3.1-3.3(Vol.II)) **Regulatory aspects of efficient energy use.** Kahn, A.E. 1976.

From EPRI workshop on technologies for conservation and efficient utilization of electric energy; San Diego, CA, USA (26 Jul 1976).

In Proceedings of an EPRI workshop on technologies for conservation and efficient utilization of electric energy. Volume I. Executive summary; Volume II. Working papers.

The need for the electric utilities industry to promote research to achieve greater energy efficiency in power generation and transmission and efficiency and conservation in the end use of electric power is discussed. The role of peak load pricing in conservation efforts is mentioned. (LCL)

35463 (EPRI-EM—313-SR, pp 3.15-3.26(Vol.II)) **Areas of regulatory interest in efficient energy use research and development.** Cavagnaro, W.J. 1976.

From EPRI workshop on technologies for conservation and efficient utilization of electric energy; San Diego, CA, USA (26 Jul 1976).

In Proceedings of an EPRI workshop on technologies for conservation and efficient utilization of electric energy. Volume I. Executive summary; Volume II. Working papers.

Areas of special regulatory interest in efficient energy use, research and development include: time of use metering; communications system related to measuring and controlling energy use; demand management and energy management systems; solar energy utilization; heating and cooling storage systems; and waste heat utilization. Activities of the National Association of Regulatory Utility Commissions in studying these subjects are described.

35464 (EPRI-EM—313-SR, pp 4.1-4.8(Vol.II)) **Utilities' stake in efficient electricity use.** DeYoung, J. 1976.

From EPRI workshop on technologies for conservation and efficient utilization of electric energy; San Diego, CA, USA (26 Jul 1976).

In Proceedings of an EPRI workshop on technologies for conservation and efficient utilization of electric energy. Volume I. Executive summary; Volume II. Working papers.

The role of electric utilities in promoting energy conservation, factors which affect conservation in the generation and end use of electric power, and recommendation for R and D programs which will result in abundant electric power for all at a reasonable cost are discussed. (LCL)

35465 (EPRI-EM—313-SR, pp 4.9-4.14(Vol.II)) **Utility R and D needs in efficient use of energy.** Greiner, P.C. 1976.

From EPRI workshop on technologies for conservation and efficient utilization of electric energy; San Diego, CA, USA (26 Jul 1976).

In Proceedings of an EPRI workshop on technologies for conservation and efficient utilization of electric energy. Volume I. Executive summary; Volume II. Working papers.

The need for emphasizing research on customer end-use of electric power in order to achieve energy conservation is discussed. End-uses for residential and industrial power demand are described. It is recommended that conservation studies include improved buildings and their thermal insulation, waste heat utilization, solar energy utilization, and improved equipment and control devices. (LCL)

35466 (EPRI-EM—313-SR, pp 4.15-4.32(Vol.II)) **Seattle's long-term electric energy conservation program and its R and D implications.** Sheehan, R.G. 1976.

From EPRI workshop on technologies for conservation and efficient utilization of electric energy; San Diego, CA, USA (26 Jul 1976).

In Proceedings of an EPRI workshop on technologies for conservation and efficient utilization of electric energy. Volume I. Executive summary; Volume II. Working papers.

In 1976 the Seattle City Council ordered a comprehensive review of all aspects of energy needs, energy strategy, and alternatives for the City as a prerequisite for the City's participation in proposed construction of two nuclear power plants by the Washington Public Power Supply System. The general public, city committees, and professional electric power consultants contributed to this review. The results of the study in terms of public attitudes toward energy conservation, the conservation goals which were identified, and research areas which the electric utility industry should pursue to achieve these goals are discussed. (LCL)

35467 (EPRI-EM—313-SR, pp 5.21-5.43(Vol.II)) **R and D needs in industry and commerce.** Looney, Q. 1976.

From EPRI workshop on technologies for conservation and efficient utilization of electric energy; San Diego, CA, USA (26 Jul 1976).

In Proceedings of an EPRI workshop on technologies for conservation and efficient utilization of electric energy. Volume I. Executive summary; Volume II. Working papers.

Energy management R and D projects which could begin immediately and which would result in electric power conservation in industry and commerce are discussed. These projects should include studies to; enhance efficiency in areas where electricity is currently used; initiate or increase understanding of the concept of "efficiency" in the minds of end users; substitute electricity for other fuels in an "energy efficient" way; reduce peak demands; recover waste heat from electricity using devices; and develop new processes or improved process control techniques to accomplish widely performed tasks (heat, light, motion, chemical reaction, etc.) with lower primary energy requirements. Examples of immediate implementation possibilities in each of these study categories are presented. (LCL)

35468 **Taetorternas och den tunga industrins energifoersoerjning. Utredningfraan Statens Industriverk. (Energy management of densely built-up areas and heavy industry. Investigation from Statens Industriverk).** Stockholm; Liber Foerlag (1976). 307p.

Improvement of energy management in different industries, mainly pulp, paper, iron and steel, is discussed. Possibilities of further development of waste heat in terms of heating industrial buildings is presented. Heavy industry uses approximately 43 percent of Sweden's total energy consumption. A considerable increase is expected within the next ten years. The pulp and paper industries account for the highest energy consumption: electricity 33 percent and fuel 45 percent. It is estimated that it is possible to decrease these figures by 7 percent but at a cost of an estimated 500 million crowns. Cooperation between industry and community planning can do much to help the present situation. Development of district heating is also discussed.

35469 **World mining and metals technology. Volume II.** Weiss, A. (ed.). New York; American Inst. of Mining, Metallurgical, and Petroleum Engineers, Inc. (1976). 548p. (CONF-7609165—P2). .

From Proceedings of the joint MMIJ-AIME meeting; Denver, CO, USA (1 Sep 1976).

Thirty-four papers were presented at the meeting. A separate abstract was prepared for each of 9 papers. One paper appeared previously in ERA. The remaining 25 papers are not in the scope of ERA. (LCL)

ENERGY SOURCES

REFER ALSO TO CITATION(S) 35350

35470 Combined heat and power generation in a brewery. Gneuss, G. *Energie;* **29**: No. 5, 143-145(May 1977). (In German).

A brewery in Southern Germany is used as an example to demonstrate the close connection between increased and rationalized production and the exploitation of all ways and means of more efficient energy consumption. Installing a uniform pressurized steam system for all steam consumers, meaningful harmonization of the operating periods of the individual steam consumption centers, and reduction of the expensive peak load supplies from the public grid helped to decrease production costs by means of a reduction in energy costs. The heat power plant, which is now operated in an evenly balanced load regime, is now even able to deliver excess electricity into the grid. When the production and power plants had to be enlarged even further, a decision had to be taken either in favor of a turbine or a high speed steam engine system. The decision was taken in favor of the steam engine, because of its higher efficiency, i.e., better utilization of the steam, and also for the capability of the steam engine system to be operated in a fully automated pushbutton mode. The primary energy requirement of the plant electricity generation system is now only half the requirement of public condensation power plants on a kilowatthour basis. In this way, energy consciousness in heat consuming industries helps to achieve more efficient energy consumption.

35471 Possible breakthrough for the use of electric power in iron and steel plants. Astier, J. (Inst de Rech de la Sider, Fr). *Rev. Metall. (Paris);* **74**: No. 8/9, 493-503(1977). (In French).

Energy balances are compared for the two ways of steelmaking; viz., oxygen conversion of hot metal from the blast furnace and melting of scrap or prereduced ore in the arc furnace. The possibilities of wider application of the arc furnace in the near future are weighed. Adoption of electric reduction furnaces or continuous arc or induction furnaces, the use of electronuclear energy for prereduction of ore, and electrolysis of iron ore are considered as possible later developments.

EQUIPMENT AND PROCESSES

REFER ALSO TO CITATION(S) 35446, 35486

35472 (CONF-7511129—, pp 177-182) **Criteria of selection and operation of machines for energy saving in plants.** Andrenelli, A. (Nuovo Pignone, Florence). 1975.

From 159. international assembly of the European Federation of Chemical Engineering; Milan, Italy (10 Nov 1975).

In Energy saving in chemical processing.

The recent substantial increase in energy costs is an inducement to re-consider the value of certain approaches in selecting, operating, and engineering the compressors used in chemical processes. A careful assessment of the yields from centrifugal and reciprocating compressors can displace their present areas of application. The operation of these machines may--as it is intended for maximum outputs--lead to working even under inadequate efficiency conditions. Proper maintenance and a better knowledge of the equipment can ensure higher efficiencies without impairing production. The designed conditions established in compressor engineering frequently are a compromise of the different operating conditions under which the unit is expected to be actually operting in time. On occasions, such compromise may be such as to make the units work under conditions largely at variance with those of maximum efficiency. When these operating conditions are expected to last over prolonged periods of time, this can be accounted for in designing the units. Replacing even minor parts can be enough to afford major energy savings. In any event, a better information exchange between the process engineer and the compressor manufacturer in the designing step will facilitate obtaining of optimum approaches to both the engineering work and the operation of these units.

35473 (CONF-7511129—, pp 461-490) **Relative influence of operating and fixed costs in optimization of industrial units: chemical reactors, matter and heat exchangers.** Le Goff, P.; Midoux, N. (ENSIC-CNRS, Nancy). 1975.

From 159. international assembly of the European Federation of Chemical Engineering; Milan, Italy (10 Nov 1975).

In Energy saving in chemical processing.

The dimensions and the operating conditions of an exchanger or of a chemical reactor are optimized by calculating the best possible compromise between operting costs (which are assumed to be proportional to the mechanical energy dissipated) and fixed costs (equipment, construction, maintenance). The formula for calculating the optimal value of the cross-section of a cylindrical exchanger or reactor is presented.

35474 (CONF-7511129—, pp 593-610) **Ammonia urea integrated process: a contribution to the reduction in energy consumption and plant cost.** Pagani, G.; Zardi, U. (Snam Progetti, S. Donato Milanese, Italy). 1975.

From 159. international assembly of the European Federation of Chemical Engineering; Milan, Italy (10 Nov 1975).

In Energy saving in chemical processing.

The present energy crisis has caused not only an increase in the cost of energy but also a considerable rise in the cost of services in general and of the transformation plants in particular. These events, added to remarkable financing difficulties, present to the technician considerable problems of choice and optimization. In fact, it is not always clear whether it is more convenient to reduce energy consumption to the detriment of the plant cost or vice versa. On the contrary, it is clear that the best solution is to operate in both directions, namely, to improve the transformation processes in order to reduce both costs and consumption. The ammonia urea integrated process is in line with this purpose and, because of the elimination of some expensive working stages and the employment of special equipment, has advantages of considerable importance which cannot be obtained with normal improvements and optimization of conventional processes. A description is given of the features and performance of the new process with emphasis on the experimental tests carried out in a semi-scale plant and the results obtained.

35475 (CONF-7511129—, pp 635-650) **Examples of possible energy savings in chemical industry.** Biondi, L. (Montedison, Milan). 1975.

From 159. international assembly of the European Federation of Chemical Engineering; Milan, Italy (10 Nov 1975).

In Energy saving in chemical processing.

Many levels of intervention aimed at energy savings in the chemical industry are examined. These include improvement of component efficiency; finding of the best energy administration; and choice of the best processes and products in relation to energy conservation. The problem of the best energy administration inside an existing chemical plant with the best arrangement of process equipment and the possible adoption of special devices, i.e., topping cycles or gas turbines, is discussed. An energy analysis methodology is described and examples are given concerning some suggested applications to chemical plants.

35476 (EPRI-EM—313-SR, pp 2.1-2.5(Vol.II)) **Energy R and D needs of a municipal utility's industrial customers.** Adrian, L.O. 1976.

From EPRI workshop on technologies for conservation and efficient utilization of electric energy; San Diego, CA, USA (26 Jul 1976).

In Proceedings of an EPRI workshop on technologies for conservation and efficient utilization of electric energy. Volume I. Executive summary; Volume II. Working papers.

An analysis was made of the end-use of electricity by industrial customers in Los Angeles, Ca. in order to identify areas where end-use efficiency could be improved to affect energy conservation. The methods used to survey the industrial customers are discussed, and results in terms of percentage of total electric power demand used for specific purposes in industrial plants, e.g., motor loads, space conditioning, process heat, etc. are presented. (LCL)

35477 (EPRI-EM—313-SR, pp 2.6-2.13(Vol.II)) **Industry: the conserver.** Whiting, M. 1976.

From EPRI workshop on technologies for conservation and efficient utilization of electric energy; San Diego, CA, USA (26 Jul 1976).

In Proceedings of an EPRI workshop on technologies for conservation and efficient utilization of electric energy. Volume I. Executive summary; Volume II. Working papers.

The characteristics of energy use by six major energy intensive industries, chemical, metal, petroleumm, glass, paper, and food, are outlined, and research topics which should be studied to promote energy conservation in industry are presented. (LCL)

35478 (EPRI-EM—313-SR, pp 2.25-2.33(Vol.II)) **Electrical energy conservation needs in industry.** Breckenridge, L. 1976.

From EPRI workshop on technologies for conservation and efficient utilization of electric energy; San Diego, CA, USA (26 Jul 1976).

In Proceedings of an EPRI workshop on technologies for conservation and efficient utilization of electric energy. Volume I. Executive summary; Volume II. Working papers.

The economics of energy conservation, particularly decreased electric power consumption, in industry and the problems caused by uncertainties in the future cost of elejtric power are discussed. Specific R and D needs to promote energy conservation are described using industrial drying and the glass industry as examples. It is concluded that the heart of the problem of industry in

conservation and efficient utilization of electrical energy is the need to show how the complete plant is affected by the change in "technology." When all of the rhetoric clears, the bottom line for profit or loss remains. It is on this basis that most, if not all, programs for implementing energy conservation will be decided during the immediate future. Associated with estimates of project costs and their impact on future profits, is the risk or uncertainty involved. It is believed that there is a great need for advancing existing technology, which has already been through the initial R and D stages into a first commercial stage. This step is necessary in order for the monetary risk to be reduced to a satisfactory level. Perhaps more important than the demonstration of technology, the projects described above would reduce the uncertainty to a level where plant managers would believe it could work in their plant.

35479 (EPRI-EM—313-SR, pp 5.74-5.77(Vol.II)) **Technology of building and building technology.** Eberhard, J.P. 1976.

From EPRI workshop on technologies for conservation and efficient utilization of electric energy; San Diego, CA, USA (26 Jul 1976).

In Proceedings of an EPRI workshop on technologies for conservation and efficient utilization of electric energy. Volume I. Executive summary; Volume II. Working papers.

Whether the technology of building or building technology will be the larger challenge to the research community is not yet clear. In either case, the electric power industry will continue to be challenged to understand the difference between the two kinds of demand and will need to forecast the future developments likely to effect technological change in buildings or the building industry.

35480 **New cement plant uses dry process.** Bottomley, P. *West. Miner;* **50**: No. 11, 15-16, 18(Nov 1977).

Built by Inland Cement Industries Limited, the Tilbury Island plant in Delta, British Columbia, has the largest kiln in Canada. The plant uses a dry process rather than the wet process and, is more energy efficient. An energy consumption of 38 therms or 4070 megajoules per tonne produced is anticipated. No water is mixed with the constituents. Waste gases from the kiln are used to pre-dry the material in the raw mill. It then travels through the homogenizing process and a four-stage heater, by which time part of the calcining has already taken place.

35481 **Calculation of optimal sections of rotors of regenerative air heaters with two-layered packing.** Zmachinskii, A.V.; Shleifer, B.M. (Saratov Polytech Inst, USSR). *Teploenergetika (Moscow);* No. 8, 43-45(Aug 1977). (In Russian).

The existing methods of calculation permit selection of rotor sections of regenerative air heaters ensuring optimal gas and air velocities in the "hot" packing layer only. The paper presents a method which ensures rotor section optimality for both the "hot" and "cold" layer, thus reducing the cost of expensive packing sheet material provided with corrosion-resisting coating. Appropriate formulas are derived and an example of rotor section selection is given.

35482 **Integrated flexible manufacturing systems: towards automation in batch production.** Arndt, G. (Univ. of Auckland, New Zealand). *N.Z. Eng.;* **32**: No. 7, 150-155(15 Jul 1977).

Computers and other modern control methods are increasingly capable of providing the degree of automation and flexibility needed for rational batch production. This mode of hitherto quite-inefficient manufacturing predominates not only in New Zealand and Australia, but also in most of the highly industrialized countries such as Germany, Japan, and the United States, where integrated, flexible manufacturing systems capable of automatic batch production are increasingly being developed. The paper describes the rationale for this type of system, its characteristics and implications and illustrates these by way of prototype plants already in operation, briefly touching on the concept of the "automatic factory." The unique manufacturing situation of both New Zealand and Australia seems to lend itself ideally for the application of such flexible manufacturing systems. A first step in this direction, leading in itself to higher productivity, would be to overcome traditional reservations and to implement rigorously the use of group technology and numerically controlled machining in local manufacturing industry.

35483 **Coal conservation and blast furnace productivity.** Mitra, A.N.; Chakravarty, P.K. (Tata Iron and Steel Co, Ltd, Jamshedpur, India). *TISCO;* **24**: No. 2, 51-56(Apr 1977).

Blast furnace productivity drops markedly beyond 23.0% ash in coke. When the percentage of ash in coal is higher than 18.0%, the strength of the coke suffers. At higher ash levels, blast furnace productivity goes down due to poorer coke strength, which is the direct result of higher ash contents. The demand for coking coal would be less and, therefore, the coking coal reserves would last longer, if blast furnaces are operated with 23% ash coke rather than 25% ash coke. 5 refs.

35484 **Thermal efficiency and initial operation of roller-hearth conveyor furnaces for normalizing steel plate for the 3600 mill.** Kurbatov, Yu.L.; Karbyshev, V.T.; Kazantsev, E.I.; Krivenko, P.T.; Gamashova, N.M. (Donetsk Polytech Inst, Ukr SSR). *Steel USSR;* **6**: No. 11, 637-640(Nov 1976).

When roller-hearth conveyor furnaces were being started up for normalizing plate for the 3600 mill, using heat from rolling, difficulties were encountered, associated with loss of output on changing from one plate thickness to another and because of the necessity for cooling plates more than 20 mm thick. Equations are given for calculating output, the rate of movement of plate in the furnace, and the charging rate for metal with the furnaces running in steady conditions. Details are given for calculating the thermal balances which are instantaneous for plates of one set of dimensions and averaged for plates of different batches.

WASTE HEAT RECOVERY AND UTILIZATION

REFER ALSO TO CITATION(S) 34626, 34967, 34968, 35102, 35128, 35409, 35475

35485 (CONF-7511129—, pp 413-430) **Downstream energy recoveries in equipment and machinery plants.** Bellofatto, O. (Snam Progetti, S. Donato Milanese, Italy). 1975.

From 159. international assembly of the European Federation of Chemical Engineering; Milan, Italy (10 Nov 1975).

In Energy saving in chemical processing.

Energy recovery in chemical plants is discussed in terms of the types of energy available in pressurized, heated, or refrigerated fluids; systems for recovering energy such as turbines, heat recovery equipment and evaporators; uses of steam produced with heat recovery equipment; and specific types of chemical plants in which energy recovery is used. (LCL)

35486 (CONF-7511129—, pp 523-546) **Heat exchangers.** Bradley, D. (Chemical Engineering Developments, London); Cowan, G.H. 1975.

From 159. international assembly of the European Federation of Chemical Engineering; Milan, Italy (10 Nov 1975).

In Energy saving in chemical processing.

The contribution of the heat exchanger to thermal energy utilization in the chemical processing industries is reviewed. The review covers the magnitude of the contribution and indicates the savings that can be made by: proper attention to operating conditions in existing process plants; better design of heat transfer systems in new process plant; optimum selection of heat transfer equipment including for example, the choice of air cooling versus water cooling and of plate heat exchangers versus shell and tube heat exchangers; better design of heat exchangers and the use of modern computer design techniques that are based on continuing research programs; and better techniques and their application to heat exchanger design, e.g., the use of enhanced heat transfer surfaces. Examples of industrial practice are given in each of these categories with the examples including quantitative information on thermal energy savings as far as is possible.

35487 **Waste heat recovery and use in the British Steel Corporation.** Dugwell, D.R. (Br Steel Corp, Battersea Lab). *Steel Times;* **205**: No. 8, 784-786, 788-73(Aug 1977).

The BSC has completed a survey of energy rejection patterns of all the major works. The survey was undertaken to catalog waste heat sources according to origin, temperature, quality, and condition, and to identify the most economically promising recovery opportunities. The study considered energy rejection on a process by process basis. The energy savings quoted have been calculated for a modern integrated works with an annual output of 2 million ingot t (40,000 t/wk), except in the case of the blast furnace where a 14 m hearth, 10,000 t/day unit has been considered. BSC has produced a new ceramic recuperator which fills the need for higher preheat temperatures on soaking pits.

INDUSTRIAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 34935, 34939, 34945, 36023

35488 (CONF-7511129—, pp 561-574) **Regeneration of the spent oils.** Audibert, M.M.; Bonnefond, P.; Quang, D.V.; Vidol, A. (Institut Francais du Petrole, Rueil Malmaison). 1975.

From 159. international assembly of the European Federation of Chemical Engineering; Milan, Italy (10 Nov 1975).

In Energy saving in chemical processing.

The answer to the question about what to do with used oils, must take into consideration three basic points: spent oils are a pollutant; can be burned; and can be reclaimed into good quality base oils (equivalent to new oil). The spent oils are an important source of pollution of water and soils. Furthermore, spent oils can be considered equivalent to a leakage of raw petroleum oil (roughly 60% of the petroleum oil leakage from human activities). A generalized discussion of used oil handling is presented, i.e., burning and regeneration into base oils. An important development of treating

capacities as well as a concentration to larger units can be expected for this industry.

35489 Phase composition of ash residues of fuel oil. Sirina, T.P.; Arbuzova, N.A.; Pershina, R.F.; Arbuzov, V.A.; Krasnoselov, G.K.; Slotvinskii-Sidak, N.P.; Sidorova, G.A. *Therm. Eng. (USSR) (Engl. Transl.);* **24**: No. 3, 30-33(1977).

Translated from Teploenergetika; 24: No. 3, 38-41(1977).

Ash residue of high-sulfur oils may be one of the promising sources of vanadium. The composition of the ash depends on the quality and conditions of combustion of the oil and the point of sampling. Representative samples from heat and power stations were used for investigation. In studying the phase composition of ashes the following five groups of compounds were found: sulfates, soluble in water completely or partly; sodium-vanadium compounds; spinellides, magnetic and nonmagnetic; oxides of metals; and compounds containing no vanadium and no nickel. Vanadium is in ashes in the form of vanadyl sulfate in tetravalent state, in sodium-vanadium bronzes in tetra- and penta-valent states, and in some magnetic and nonmagnetic spinellides in trivalent state. Besides these compounds, vanadium is found in the form of an isomorphic component with hamatite and in the form of vanadium trioxide V_2O_3. The phase richest in nickel is iron-nickel spinellide. Nickel is also present in other spinellides and with hematite.

35490 Investigation of the deposits formed when burning high-sulphur oils, as a source for obtaining vanadium. Sirina, T.P.; Leitsin, V.A.; Krasnoselov, G.K.; Pershina, R.F. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 4, 45-47(1976).

Translated from Teploenergetika; 23: No. 4, 66-68(1976).

A future source of vanadium may be the deposits which form on the heating surfaces of boilers when burning oil of high sulfur content. Such material contains a considerable quantity of vanadium, sometimes exceeding its content in convertor slags. The quantity of water- and acid-soluble compounds of vanadium and nickel were determined, and the composition of the insoluble constituents of the deposits were investigated. The method of determining the soluble form consisted of treating a weighed portion of 1 g in 100 ml of solvent (water or 7% sulfuric acid), with boiling for 10 minutes. The overall content of vanadium, nickel and tetravalent vanadium were determined separately. The content of the water-soluble form of vanadium varied within comparatively wide limits, from 1.5 to 15.3%, while all the vanadium was present in the tetravalent form. The soluble form of nickel ranged from 16.1 to 43%.

35491 New process for copper anode slime treatment at the Hitachi Smelter and Refinery. Sato, J. (Hitachi Smelter and Refinery of Nippon Mining Co., Ltd., Japan); Imamura, T.; Hojo, M.; Suzuki, T. pp 585-598 of World mining and metals technology. Volume II. Weiss, A. (ed.). New York; American Inst. of Mining, Metallurgical, and Petroleum Engineers, Inc. (1976).

From Proceedings of the joint MMIJ-AIME meeting; Denver, CO, USA (1 Sep 1976).

See CONF-7609165—P2.

Hitachi Refinery of Nippon Mining Co., Ltd., was constructed in 1911. The refinery began early to recover by-product metals and to manufacture copper products. Today, the refinery recovers gold, silver, selenium, platinum and palladium as by-products of the copper refining process and manufactures copper powder, copper foil, wire bars and chemicals for plating. In 1969, the capacity of the refinery reached 6,000 tons/month (T/M). Because, at that time, the forecast was for the demand for copper in Japan to increase, planning for the expansion of the Hitachi and Saganoseki refineries was begun. A new 10,000 T/M capacity tank house, a new electrolyte purification plant and an enlarged anode slime treatment plant were planned. The development of new machines and processes has resulted in an efficient refinery with a production capacity of 16,000 T/M. The new anode slime treatment plant and especially on the copper removal process, the ferric leaching process, are discussed.

35492 Recovery of zinc from steelmaking dust. Miyashita, T. (Onahama Refinery of Ryoho Recycle Co., Ltd., Japan). pp 622-629 of World mining and metals technology. Volume II. Weiss, A. (ed.). New York; American Inst. of Mining, Metallurgical, and Petroleum Engineers, Inc. (1976).

From Proceedings of the joint MMIJ-AIME meeting; Denver, CO, USA (1 Sep 1976).

See CONF-7609165—P2.

Onahama Refinery of Ryoho Recycle Company employs the electrothermic process for producing marketable zinc oxide from steelmaking dusts. The process comprises washing, filtration, drying, sintering and heating. Fumes from the sinter machine are treated hydrometallurgically to recover zinc, cadmium and lead.

35493 Integrated recycling of wastewater by application of ion, precipitate and ultrafine-particle flotation in the lead-zing concentrator of Kamioka mine. Ishizu, A. (Mitsui Mining and Smelting Co., Ltd., Gifu-ken, Japan); Mtsui, N.; Nagahama, T. pp 754-776 of World mining and metals technology. Volume II. Weiss, A. (ed.). New York; American Inst. of Mining, Metallurgical, and Petroleum Engineers, Inc. (1976).

From Proceedings of the joint MMIJ-AIME meeting; Denver, CO, USA (1 Sep 1976).

See CONF-7609165—P2.

In the concentrator of the Kamioka Mine, lead-zinc bulk differential flotation is practiced. It results in three kinds of thickener overflow, namely; tailing, lead concentrate, and zinc concentrate, which are discharged as wastewater. Since these three kinds of overflow differ from each other in water quality, they are separately recycled to appropriate processes based on their water quality. The tailing and the lead concentrate thickener overflow are directly recycled to their respective suitable processes. However, as the zinc thickener overflow contains $Cu(CN)_3^{2-}$, ZnS, CdS, CN^-, xanthate and froth, the total zinc thickener overflow cannot be recycled at one time to any one process without creating harmful effects. Consequently, all the ingredients in the zinc thickener overflow other than CN^- are floated by Ion-Precipitate-Ultrafine-particle flotation, using Nagahm flotation machine. After this treatment, the zinc thickener overflow, containing only CN^-, is effectively recycled to the lead-zinc differential flotation circuit. Thus the integrated recycling of wastewater greatly reduces environmental problems, and in addition, it generates a sizeable profit by improving overall mill recovery, and permitting the reduction of reagent consumption.

35494 Recovery of heavy metals from the waste water of sulfuric acid process in Ashio Smelter. Murao, K.; Nakao, S. (Furukawa Co. Ltd., Ashio, Japan). pp 808-816 of World mining and metals technology. Volume II. Weiss, A. (ed.). New York; American Inst. of Mining, Metallurgical, and Petroleum Engineers, Inc. (1976).

From Proceedings of the joint MMIJ-AIME meeting; Denver, CO, USA (1 Sep 1976).

See CONF-7609165—P2.

The equipment and processes used at the Ashio copper mine in Japan for treating waste water from the mine, the ore dressing facility, and the smelter in order to both control pollution and to recover heavy metals, particularly arsenic and copper are described. This plant which has been in operation since 1971 at present produces 120 t/month of refined arsenic trioxide. (LCL)

35495 Lead smelter flue gas desulfurization by the citrate process. Nissen, W.I.; Crocker, L.; Martin, D.A. (Dept. of the Interior, Salt Lake City). pp 825-854 of World mining and metals technology. Volume II. Weiss, A. (ed.). New York; American Inst. of Mining, Metallurgical, and Petroleum Engineers, Inc. (1976).

From Proceedings of the joint MMIJ-AIME meeting; Denver, CO, USA (1 Sep 1976).

See CONF-7609165—P2.

The Federal Bureau of Mines has developed a process for removing SO_2 from stack gases. The process comprises absorption of SO_2 in an aqueous solution of sodium citrate, citric acid, and sodium thiosulfate, followed by reaction of the absorbed SO_2 with H_2S to precipitate sulfur and regenerate the citrate solution for recycle. A pilot plant was operated at The Bunker Hill Co. lead smelter in Kellogg, Idaho, to assess the feasibility of using the process for flue gas desulfurization. Nominal capacity of the pilot plant, which treated tail gas from the lead smelter sintering furnace, was 1699 standard m^3/hr (15 degrees Celsius) of 0.3 to 0.7%-SO_2 gas yielding about 272 net kilograms of sulfur per day. The pilot plant was operated for about 4500 hours and produced more than 45 net tons of sulfur. Projected operating costs, including capital charges, for a citrate plant, installed at a 118,000-tons-per-year lead smelter and treating 49,271 m^3/hr of lead smelter sintering furnace tail gas, are estimated to be $384 per ton of sulfur.

35496 Bismuth recovery from copper smelting dust. Asahina, S.; Hosokura, K.; Hayashi, T. (Sumitomo Metal Mining Co., Ltd., Ichikawa, Japan). pp 856-874 of World mining and metals technology. Volume II. Weiss, A. (ed.). New York; American Inst. of Mining, Metallurgical, and Petroleum Engineers, Inc. (1976).

From Proceedings of the joint MMIJ-AIME meeting; Denver, CO, USA (1 Sep 1976).

See CONF-7609165—P2.

Sumitomo Metal Mining Co., Ltd.'s Kunitomi Smelter has been treating in the blast furnace copper concentrate containing bismuth. The bismuth is concentrated in the electrostatic precipitator dust and the converter dust. Bismuth contained in the converter dust is leached by a mixture of salt and sulfuric acid, and is then recovered by a cementation process using scrap iron. The bismuth cake thus recovered and the electrostatic precipitator dust are reduced to crude bismuth metal which is further refined to a high purity bismuth metal by the pyrometallurgical refining process. Details of this process are discussed.

MUNICIPALITIES AND COMMUNITY SYSTEMS

PUBLIC SERVICES

35497 (CONF-7510172—P1, pp 47-52) **Review of the Federal Highway Administration Program.** Perchalski, F.R. (Federal Highway Administration, Washington, DC). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The Federal Highway Administration and its precursor, the Bureau of Public Roads, have promoted the increased use of remote sensing techniques for at least the past 30 years. Early emphasis was on photointerpretation for engineering soils mapping and construction materials exploration. For the past 10 years, however, investigations of engineering applications of a wide range of sensing techniques have been undertaken as a cooperative State/Federal/Contract effort. This approach to operational engineering applications has been formalized into the current Federally Coordinated Program of Research and Development. The flexibility of cooperative efforts and continued interest in remote sensing developments will allow the Federal Highway Administration to provide practicing transportation engineers with more effective approaches to many current and anticipated problem areas.

MUNICIPAL WASTE MANAGEMENT

REFER ALSO TO CITATION(S) 36023

35498 **Resources recovery from municipal solid waste in Japan.** Tomita, K.; Moro, T.; Yamagata, Y.; Kokubo, T. (Agency of Industrial Science and Tech., Saitama, Japan). pp 909-928 of World mining and metals technology. Volume II. Weiss, A. (ed.). New York; American Inst. of Mining, Metallurgical, and Petroleum Engineers, Inc. (1976).

From Proceedings of the joint MMIJ-AIME meeting; Denver, CO, USA (1 Sep 1976).

See CONF-7609165—P2.

Owing to the necessity for the collection and transportation of wastes, air and water pollution in incineration plants, and the sanitary problems in reclaimed land, it seems that the defective existing system of solid waste treatment in Japan can not follow the change in quality and the increase in quantity of solid wastes. Under these situations, the objective of the municipal solid waste treatment must be to actualize the pollution-free system for environmental protection and the resources recovery system for resource and energy saving. From this point of view, AIST of Japan is now engaged in the research and development of the resources recovery system from municipal solid wastes. The development of resources recovery technology in Japan, including the AIST's project on this matter, is reported.

ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

INTERNAL COMBUSTION ENGINES

35499 (NATO/CCMS—61(Vol.1)) **Proceedings of the fourth international symposium on automotive propulsion systems. Volume I.** (North Atlantic Treaty Organization, Brussels (Belgium). Committee on the Challenges of Modern Society; Department of Energy, Washington, D.C. (USA). Div. of Transportation Energy Conservation). Feb 1978. 529p. (CONF-770430—P1). Dep. NTIS, PC A23/MF A01.

From 4. international symposium on automotive propulsion systems; Washington, DC, USA (17 Apr 1977).

Fifty-two presentations are given in Volume I with contents including: (1) preliminary remarks and keynote address; (2) government/industry summary reports; (3) gas turbines; (4) Stirling and Rankine engines; (5) diesel engines; (6) stratified charge engines; and (7) spark ignition improvements. All of the technical papers presented are condensed versions of papers appearing in the original conference draft. A separate abstract for each paper was previously prepared for DOE Energy Research Abstracts (ERA) as being part of the DOE Conference 770430, parts 1 to 5 (draft). (PMA)

SPARK-IGNITION

REFER ALSO TO CITATION(S) 35508, 35509, 35513, 35516

DIESEL

REFER ALSO TO CITATION(S) 35521

35500 (SAN—1099-1) **Automotive diesel technology program. Final report, June 1975—April 1977.** Hill, S.H. (Teledyne Continental Motors, Muskegon, Mich. (USA). General Products Div.). Aug 1977. Contract EY-76-C-03-1099. 124p. Dep. NTIS, PC A06/MF A01.

The work reported was performed under Contract with the Energy Research and Development Administration (ERDA), Division of Transportation Energy Conservation. The Diesel Technology Program was conducted during the June 1975 through April 1977 period. The program philosophy was to design and develop a diesel engine concept to meet the ERDA specification for a 3000 pound car, and to demonstrate with existing hardware, that the technology of the concept engine could meet the specification goals. The preliminary design was finalized for a lightweight automotive diesel that can meet ERDA specification goals. It was demonstrated that technology included in the concept design can meet the emission and fuel economy goals of 0.41HC/3.4 CO/0.4NO/sub x/ and 25 miles per gallon on the Federal Urban Driving Cycle. The major conclusions reached during this program are that a variable compression ratio (VCR) swirl chamber diesel with variable injection timing and exhaust gas recirculation (EGR) can: (1) achieve emissions of 0.41 HC/3.4 CO/0.40 NO/sub x/; (2) have fuel economy 55 percent better (MPG) than comparable gasoline engines; (3) have an early introduction into production over present gasoline engine lines; (4) have a broad fuel tolerance (unleaded gasoline was run); and (5) be smaller in size and comparable in weight to existing gasoline engines.

TURBINE

REFER ALSO TO CITATION(S) 34746, 34747, 34859

35501 **World market trends and developments.** Mountford, D. *Gas Turbine World;* No. Spec. Adv. Suppl., 5-6(Mar 1978).

By analyzing current and future market demands and trends and building a product range to satisfy requirements of size, efficiency, and price, Rolls Royce IMD figures to increase its share of the world's gas turbine market. Worldwide emphasis on efficiency, increased mechanical drive demand, and changing patterns in marine markets are discussed.

35502 **High-efficiency SM1A extends marine line.** Page, K. *Gas Turbine World;* No. Spec. Adv. Suppl., 12-15(Mar 1978).

With 15% to 20% better specific fuel consumption than first generation engines, and extremely good part-load characteristics, the 15,000-bhp class marine Spey fills the power gap between the 5,000-bhp Tyne and 28,000-bhp Olympus engines. Endurance running is scheduled for 1980. High efficiency part loads, aero-derivative design details, and a new marine power turbine are discussed.

ROTARY

REFER ALSO TO CITATION(S) 35519

EXTERNAL COMBUSTION ENGINES

REFER ALSO TO CITATION(S) 35499

ELECTRIC-POWERED SYSTEMS

REFER ALSO TO CITATION(S) 35314, 35315, 35338

35503 (CONF-7604144—, pp 20-26) **Status of electric vehicle development around the world.** Campbell, E.A. (Electric Vehicle Council, New York). 1976.

From Battery Council International convention; Mexico City, Mexico (27 Apr 1976).

In Battery Council International convention, 1976.

Advantages of electric vehicles in helping alleviate the energy crisis are pointed out. The history of electric vehicles is reviewed, and the extent of the usage—both on and off road—is presented. It is felt that the lead-acid battery is the only one available for use in the near future. Ways of making its use in electric vehicles more feasible include very fast chargers, battery exchange, hybrid systems, and a change in transportation habits. Buses, trucks, and cars already on the road are described. The need for replacement batteries for all these vehicles is pointed out. 1 table. (RWR)

35504 Recent export of electric vehicles and their electrical equipment. Kawahira, K.; Oka, H.; Sato, K. *Toshiba Rev., Int. Ed.;* No. 113, 12-17(1978).

A description is given of various electric railway vehicles and electrical equipment currently being exported by Japan. These include metrocars, suburban electric trains, electric locomotives, air conditioners, and other appliances for passenger cars. (PMA)

VEHICLE DESIGN FACTORS

BODY AND CHASSIS

35505 How sails can save fuel in the air. Hofton, A. *New Sci.;* **78**: No. 1099, 146-147(20 Apr 1978).

A brief review is given of two research efforts to develop aircraft wing-tip additions to decrease crag and increase fuel economy. The aerodynamics of these small auxiliary surfaces ("sails" or "winglets") are discussed, and some performance test results are given. (PMA)

ENGINE SYSTEM

REFER ALSO TO CITATION(S) 35500, 35534

35506 Turbocharger regulator. Richardson, N.R. (to Garrett Corp.). US Patent 4,075,849. 28 Feb 1978. Filed date 1 Sep 1976. 8p.

A turbocharger for use with an internal combustion engine is disclosed which provides regulation of gas supply to the turbine by means of an integral regulator controlled by fluid pressure.

35507 Method and apparatus for improving energy fuels. McMahon, R.C. US Patent 4,073,273. 14 Feb 1978. Filed date 11 May 1977. 4p.

The application of an electrostatic field across energy fuels subsequently burned in a reciprocating internal combustion engine improves anti-knock characteristics, thereby increasing available energy for engine operation.

35508 Fuel control apparatus for dual chamber stratified charge engine systems. Thuren, J.B.; Datwyler, W.F. Jr.; Phipps, J.R. (to Bendix Corp.). US Patent 4,071, 013. 31 Jan 1978. Filed date 18 Nov 1975. 8p.

A description is given of a fuel control apparatus for dual chamber stratified charge engine systems. A single point fuel control arrangement is used for the main (lean) air-fuel mixture in combination with a multi-point fuel injection arrangement for the igniting (rich) mixture. The single point and multi-point arrangements may be essentially independent in that they both sense and compute quantity of air flow, respectively, and meter and inject fuel respectively. In an alternate form of the invention, the air flow sensing function of the single point arrangement is used to provide suitable air flow information to the multi-point arrangement and in another alternate form of the invention the fuel flow injection function of the multi-point arrangement is used to provide suitable fuel flow information to the single point arrangement. The alternate forms of the invention reduce the overall complexity of the combined system by interrelating the single point and multi-point arrangements, thereby eliminating component and functional duplicity.

35509 Stratified combustion engine with prechamber. Goto, K. (to Toyota Jidosha Kogyo Kabushiki Kaisha). US Patent 4,071,001. 31 Jan 1978. Priority date 3 Oct 1974, Japan. 8p.

A stratified combustion engine provided with a prechamber having no inlet valve is described. The precombustion chamber comprises a first chamber communicating with a main combustion chamber, a second chamber communicating with the first chamber only through an orifice, and a discharge electrode disposed in the orifice. In the suction stroke, a lean fuel-air mixture is charged into the main combustion chamber, while a stream of a rich fuel-air mixture, which is deflected in the direction of flow by impinging against the back face of an inlet valve, is introduced into the first chamber from the main combustion chamber through a communication passage, so that the so-called stratified charge can be achieved. In the compression stroke, the rich fuel-air mixture is charged from the first chamber into the second chamber through the orifice. In the combustion process, the rich fuel-air mixture existing in the orifice is ignited and the fuel-air mixture in the first chamber is burned by the flame emerging continuously from the second chamber through the orifice so that the lean fuel-air mixture in the main combustion chamber can be burned by the flame of the rich mixture burning in the first chamber.

35510 Gas ionizing apparatus for improving the operation of an internal combustion engine. Bolasny, R.E. (to Scientific Enterprises, Inc.). US Patent 4,069,665. 24 Jan 1978. Filed date 24 Nov 1975. 16p.

A method and apparatus for producing ions wherein an ion generator produces periodic pulses of electric energy of a single polarity for some applications and alternating positive and negative polarities for other applications. A plurality of the electric pulses are limited in amplitude by a substantially sinusoidal half-wave envelope and the positive and negative pulses are preferably of different amplitudes. The ground electrode is arranged about and upstream and downstream of the ionizing electrode to provide a highly effective electric field substantially normal to the gas flow. A heater heats the gas to increase ionization. An ultrasonic sound wave generator pulses the gas with sound waves prior to, during or after ionization of the gas to group the ions of a like charge in distinct pressure wave fronts or distinct areas so as to reduce recombination of ion thereby making more ions available per volume and also increasing the total energy of the ions produced. Multiple sound wave generators increase the energy of the base frequency or selected harmonics. An inlet passage to the generator of a selected length increases the energy. A discharge passage of a selected length reinforces and/or eliminates selected harmonics. A discharge nozzle with angularly inclined and outwardly enlarged venturis cool the heated ionized gas.

35511 Inertial turbine energy storage braking and power transmission system. Pitkanen, A.R. US Patent 4,069,669. 24 Jan 1978. Filed date 18 Aug 1976. 14p.

An inertial turbine system is provided which stores energy in a rotating flywheel shell by passing a fluid, such as mercury, in and out of the shell during braking or acceleration of the vehicle in which the system is installed. The resulting fluid flywheel is coupled to an input/output shaft through a turbine transmission system. The transmission system is constructed to effect optimal energy transfer over a wide range of relative speeds between the rotating flywheel shell and the input/output shaft to which the shell is coupled.

35512 Waste heat converter for an internal combustion engine. Milling, R.W. US Patent 4,069,672. 24 Jan 1978. Filed date 24 Nov 1976. 4p.

A description is given of a waste heat recovery system for an internal combustion engine having a mixture of ammonia and water used in the cooling system. The hose and radiator portion of the cooling system is protected from high pressures within the water jacket by a pressure regulator valve. A pump is provided for pumping the coolant from the low pressure system to the high pressure system. Water vapor leaving the water jacket with the ammonia vapor is removed and returned to the water jacket by means of a rectifier. The ammonia vapor is super heated by engine exhaust gases and is then used to drive a turbine. The ammonia gas which has been cooled by expansion in the turbine is used to cool a secondary fluid before the ammonia is returned to the radiator absorber. The secondary fluid cooled by the returning ammonia vapor is used to provide cooling for the rectifier.

35513 Two-stroke internal combustion engine with stratified charge. Pattas, K.; Mueller, W. (to Daimler-Benz A.G., Stuttgart (Germany, F.R.)). German(FRG) Patent 2,346,887/B/. 23 Jun 1977. 12p. (In German).

The invention concerns a two-stroke piston internal combustion engine with stratified charge, which works with uniflow scavenging, and which operates with fuels of low boiling point. The purpose of the invention is to shape the fuel inlet in such a way that a favorable stratification of homogeneous fresh gas/waste gas mixture is formed, so that the undesirable part of the waste gases, particularly the proportion of NO/sub x/, can be kept low. This is achieved by constructive measures concerning the main combustion chamber and the ignition space.

35514 Remotely ignited lifting cylinder internal combustion engine. Schmidt, K.W. (to Daimler-Benz A.G., Stuttgart (Germany, F.R.)). German(FRG) Patent 2,556,720/A/. 23 Jun 1977. 13p. (In German).

The invention concerns a remotely ignited lifting cylinder internal combustion engine, with a combustion chamber which is divided into two chambers at the top dead center region. There is a cross-connection between the two chambers near the edge of the piston. The source of ignition is arranged in both chambers. The course of combustion can be affected by this arrangement so as to give a low proportion of nitrous oxide. Low specific fuel consumption is achieved by accelerated combustion. Apart from this, a high compression ratio is achieved, so that a relatively lean mixture can be used without any danger of loss of ignition, which can reduce the carbon monoxide content in the waste gases.

35515 Equipment for mixture preheating. Gospodar, R. (to Volkswagenwerk A.G., Wolfsburg (Germany, F.R.)). German(FRG) Patent 2,557,105/A/. 23 Jun 1977. 9p. (In German).

The invention refers to equipment for mixture preheating in internal combustion engines. The fuel-air mixture suction pipe and a thermal reactor containing engine waste gases are arranged a small distance apart on one longitudinal side of the internal combustion engine. The reactor has two separate outlet openings, one of which is connected with a main waste gas pipe direct to the waste gas

silencer, and the other is connected by a common heat exchanger surface to the heating pipe which has a suction pipe opening into the main waste gas pipe. The control of waste gas flow takes place by a throttle unit, depending on the operating condition of the internal combustion engine.

35516 Remotely ignited internal combustion engine operated with stratified charge. Renger, U. (to Volkswagenwerk A.G., Wolfsburg (Germany, F.R.)). German(FRG) Patent 2,557,232/A/. 23 Jun 1977. 11p. (In German).

The invention refers to a remotely ignited internal combustion engine operated with stratified charge, with one main combustion chamber and one pre-chamber connected with the former by a connecting duct, per cylinder. The main combustion chamber has mainly pure air introduced to it via a main inlet duct, while the fuel/air mixture is taken to the pre-chamber via an auxiliary duct. In previous similar arrangements, it was found that the whole of the fuel required could not be introduced. The invention avoids this disadvantage by a feeding arrangement in the auxiliary inlet duct, which uses the kinetic energy of the waste gas flow. Due to the feeding arrangement the pressure level of the air introduced via the auxiliary inlet duct is above ambient pressure. Thus the whole required fuel supply can be provided for the engine, even at full load.

35517 Four-stroke internal combustion engine with remote ignition and piston combustion space. Fricker, L.; Schaefer, M. (to Daimler-Benz A.G., Stuttgart (Germany, F.R.)). German(FRG) Patent 1,926,613/B/. 16 Jun 1977. 4p. (In German).

The invention concerns a 4-stroke engine with remote ignition and direct injection of fuel. Constructive measures, particularly the construction of the injection nozzle as a two hole nozzle ensure that the compression spin of the fuel air mixture is available at the time of ignition or immediately after ignition. This makes it possible to operate the internal combustion engine with a slightly later ignition setting than is normal for present day remotely ignited internal combustion engines.

35518 Internal combustion engine with waste gas turbine charge. Tholen, P.; Finsterwalder, G. (to Kloeckner-Humboldt-Deutz A.G., Koeln (Germany, F.R.)). German(FRG) Patent 2,553,821/A/. 2 Jun 1977. 9p. (In German).

This patent deals with an internal combustion engine with waste gas turbine charge. It is the purpose of the invention to improve the operational behavior of the engine, with simultaneous increase in output. This is achieved by arranging a charging air cooler in front of the opening of the connecting pipe into the charging air pressure pipe, which controls the charging air of the internal combustion engine to a preset temperature by thermostatic control. In this way, the charging air temperature in the full load region is controlled at the optimum value for combustion and for the loading of engine parts. In the part load area, the charging air is heated and diluted by the waste gas above the value required for the full load region, which has the effect of improving the waste gas by reducing the HC and NO/sub x/ emission.

35519 Rotating piston internal combustion engine of trochoidal construction. Lamm, H. (to Daimler-Benz A.G., Stuttgart (Germany, F.R.)). German(FRG) Patent 2,012,340/C/. 28 Apr 1977. 3p. (In German).

The invention refers to a rotating piston internal combustion engine of trochoidal construction. A device is to be produced in the inlet duct, which prevents wetting of the wall with fuel, and which is in a position to keep all fuel not yet mixed with air in the center of the duct, until the fuel is prepared with air. This is achieved according to the invention by providing a second throttle valve in the inlet duct and arranging the injection nozzle between the two throttle valves. The second throttle valve is provided with hinged spoilers, and the first throttle is displaced. Because of the special construction and arrangement of the throttle valves, turbulence can be created in the inlet duct, which ensures an optimum mixing over the whole load range of the internal combustion engine.

35520 Equipment for vehicles for saving fuel without loss of engine power. Weig, A. German(FRG) Patent 2,547,385/A/. 28 Apr 1977. 5p. (In German).

Equipment is described which makes savings of fuel in vehicles possible, without any loss of engine power occurring. Fast movement of the accelerator pedal is taken up by a spring, so that the carburettor linkage is subjected to gentle movements, which produces a reduction of fuel consumption. An additional linkage makes a 'kickdown effect' possible.

35521 Internal combustion engine. Eisele, E. (to Daimler-Benz A.G., Stuttgart (Germany, F.R.)). German(FRG) Patent 2,537,041/A/. 3 Mar 1977. 11p. (In German).

The invention concerns an internal combustion engine with self-ignition. It is the purpose of the invention to improve the main combustion of the engine with regard to smoke production up to a full load. This is achieved by providing the overflow duct in the opening of the main combustion chamber, which is directed to the central region of the main combustion chamber, and to the associated nearly flat piston shape, with a burner having several holes. The construction of the burner with several holes is described in detail.

EMISSION CONTROL

REFER ALSO TO CITATION(S) 35510

35522 Combination exhaust-gas cleaner and muffler for an automobile engine. Tokura, N.; Masaki, K.; Nagaisi, H. (to Nissan Motor Co., Ltd.). US Patent 4,074,975. 21 Feb 1978. Priority date 7 May 1973, Japan. 18p.

A combination exhaust-gas cleaner and muffler for particular use in an exhaust system of an automotive engine is described. The system contains a catalytic converter using a granular catalyst which is responsible for emission of dust particles of oxides of base or noble metal, comprising at least one centrifugal separator for separating the dust particles from the exhaust gases by imparting a centrifugal force to the stream of the exhaust gases, a dust collection chamber communicating with the centrifugal separator for collecting the dust particles separated from the exhaust gases and at least one silencer chamber also in communication with the centrifugal separator for dampening out noises which are borne by the exhaust gases. For the purpose of growing up the ultrafine dust into coarse particles, a particle growing chamber stuffed with a flocculent metallic material such as steel wool may be located upstream of the centrifugal separator.

35523 Low-noise-level internal combustion engine. Skatsche, O.; Thien, G.; Fachbach, H. (to Hans List). US Patent 4,071,008. 31 Jan 1978. Priority date 18 Apr 1975, Austria. 6p.

A low-noise-level internal combustion engine with an engine unit support and a cylinder head mounted on it is described. Auxiliary units are rigidly connected to the engine unit support and the cylinder head, and an engine case surrounds the engine unit support and is connected to it by at least one resonance absorbing member.

35524 Catalyst for catalytic purification of exhaust gases. Siebels, J. (to Volkswagenwerk AG). US Patent 4,070,158. 24 Jan 1978. Priority date 16 Jul 1974, German, Federal Republic of (F.R. Germany). 4p.

A description is given of a catalytic unit for treating gases, particularly exhaust gases of internal combustion engines, comprising a housing, adapted to be connected in an exhaust gas line, and a monolithic carrier body provided with a catalytic agent. The carrier body is mounted within the housing of an intermediate layer arranged in compression between the circumferential surface of the carrier body and the housing. the intermediate layer is so compressed by the surrounding housing that it exerts a pressure on the surface of the carrier body in the range of 20 to 80 N/cm^2.

NITROGEN OXIDES

REFER ALSO TO CITATION(S) 34935, 34945, 35500, 35513, 35514, 35518

35525 Method and apparatus for reducing the toxic components in exhaust gas. Linder, E.; Wossner, G.; Maurer, H.; Rieger, F. (to Robert Bosch GmbH). US Patent 4,075,992. 28 Feb 1978. Priority date 27 May 1974, German, Federal Republic of (F.R. Germany). 6p.

A portion of the exhaust gas of an internal combustion engine is returned to the induction manifold through an exhaust gas recycling line. This recycle line contains one or more orifice plates to create a measurable pressure drop when gas is flowing. The gas flow through the recycle line may be interrupted in controlled manner by a valve, particularly a magnetically actuated valve. The pressure drop across the orifice plate or plates is sensed by pressure-responsive electrical switches which provide input signals for a logical circuit that energizes a signaling device to warn the operator of a malfunction in the exhaust gas recycling system.

35526 Internal combustion engine operation utilizing exhaust gas recirculation. Mayer, E.A.; Plungis, D.W. (to Texaco Inc.). US Patent 4,075,994. 28 Feb 1978. Filed date 27 Sep 1976. 6p.

A method and apparatus are described for reducing the amount of undesirable products of combustion which are discharged to the atmosphere from an internal combustion engine. The apparatus comprises means for segregating a portion of an exhaust gas stream from the engine's exhaust discharge manifold or valve. The hot exhaust gas segment is cooled, combined with air to form a preliminary mixture, and delivered to the engine's combustion chambers. A predetermined volume of fuel is injected into the combustion chamber whereby to intermix with a portion of the preliminary

mixture in such a manner that at least a part of the latter becomes combustible. The apparatus for achieving the method comprises means for recycling the segment of the hot exhaust gas and means for controllably regulating the flow of the latter in response to the load variations imposed on the engine.

35527 Catalyst systems for the reduction of the oxides of nitrogen. Foster, G.F.; Meissner, H.E.; Stiles, J.L. (to Corning Glass Works). US Patent 4,076,792. 28 Feb 1978. Filed date 12 Apr 1972. 12p.

Devices and processes are disclosed for the treatment of waste gases, particularly automotive exhaust gases, to remove the oxides of nitrogen. Mixed noble metal catalysts consisting essentially of platinum or palladium and at least one other noble metal selected from the group consisting of ruthenium, rhodium, and iridium are employed in combination with layered oxide support coatings to eliminate ammonia formation during the removal process.

35528 Process for improved 3-way emission control. Schlatter, J.C.; Taylor, K.C. (to General Motors Corp.). US Patent 4,071,600. 31 Jan 1978. Filed date 6 Dec 1976. 10p.

A process for improved three-way emissions control is described. In the first step, the emissions stream is contacted with a catalyst consisting of rhodium supported on a refractory substrate to effect the selective chemical reduction of nitric oxide to nitrogen, the rhodium being present in an amount of at least about 0.002% by weight of the catalyst. The emissions stream is then contacted with a second catalyst consisting of at least one of the noble metals selected from the group of platinum and palladium, the noble metal being present in a small but effective amount to accomplish the oxidation of the hydrocarbons and carbon monoxide left in the emissions stream. The process is accomplished without the addition of oxygen to the emissions stream.

35529 Internal combustion engine equipped with improved exhaust gas recirculation system. Nakajima, Y.; Hayashi, Y. (to Nissan Motor Co., Ltd.). US Patent 4,071,005. 31 Jan 1978. Priority date 12 Aug 1975, Japan. 6p.

A conduit connecting the intake and exhaust systems of an internal combustion engine is equipped with a control valve for controlling the amount of exhaust gases passing through the conduit. A venturi portion constituting part of a Laval nozzle is provided to a portion of the conduit between the control valve and the intake system of the engine.

35530 Exhaust gas recirculating system. Harada, I. (to Nissan Motor Co., Ltd.). US Patent 4,071,006. 31 Jan 1978. Priority date 12 Aug 1975, Japan. 8p.

An internal combustion engine equipped with an exhaust gas recirculating system is described. The exhaust gas recirculating system comprises an EGR valve normally closing an EGR duct to prevent recirculation and movable by a signal vacuum applied thereto to an open position and control means operable to provide a signal vacuum. The control means includes a vacuum line connecting a vacuum port communicating with the carburetor throttle bore above the idle speed position of the throttle valve to the EGR valve, air bleed means including a vent in the vacuum line and flow restricting means in the vacuum line fluidly intermediate the vacuum port and vent. The air bleed means includes an air bleed control valve movable into and out of the vent to close or open the same; spring means biasing the air bleed valve closed; servo means connected to the air bleed control valve for moving it to an open vent position in response to vacuum in the vacuum line intermediate the flow restricting means and EGR valve; means for biasing the servo means in response to the engine intake manifold vacuum in a direction to move the air bleed control valve to an open vent position; and means for biasing the biasing means to vary movement of the air bleed control valve to an open vent position.

35531 Control system for engine exhaust gas recirculation according to engine opertional condition. Aono, S. (to Nissan Motor Co., Ltd.). US Patent 4,071,003. 31 Jan 1978. Priority date 5 Aug 1975, Japan. 10p.

A control system comprising a flow control valve provided in an exhaust gas recirculation passage, an electromechanical valve-actuator for actuating the flow control valve and a control circuit including function generators and an adder, optionally combined with a multiplier, for producing a control signal to operate the valve-actuator. Each function generator receives a signal representing one of several variables related to the operational condition of the engine, e.g., the opening degree of the throttle valve and engine temperature, and produces an output signal indicating and corresponding to a desirable opening degree of the flow control valve based on the assigned variable. The output signals of the function generators are respectively modulated in amplitude according to the respective importance of the variables to the exhaust recirculation control and then combined together by the adder.

35532 Internal combustio gasoline engine. Nakamura, H. (to Fuji Jukogyo Kabushiki Kaisha). US Patent 4,069,666. 24 Jan 1978. Priority date 26 Nov 1974, Japan. 8p.

An internal combustion gasoline engine is described for reducing undesirable exhaust emissions, hydrocarbons, carbon monoxide and nitrogen oxides mainly by means of the design techniques for exhaust passages. The present engine comprises two determined regions extending from an exhaust valve downwards in the exhaust passage so as to pass exhaust gases in their discharging order, one region having a volume permitting self-reaction of unburned constituents of exhaust gases therein at a temperature of the exhaust gases and another having so much volume and sectional area as capable of aspirating air by itself (automatically) through a check valve into the exhaust passage.

35533 Apparatus for recirculating exhaust gases. Nohira, H.; Tanaka, M. (to Toyota Jidosha Kogyo Kabushiki Kaisha). US Patent 4,069,797. 24 Jan 1978. Priority date 24 Jun 1975, Japan. 8p.

An apparatus is described for recirculating exhaust gases, wherein an exhaust gas recirculating passage provides communication between the intake and exhaust passages of an internal combustion engine. A constriction is provided in the passage, and a control valve is provided in the passage downstream of the constriction. A negative control pressure passage introduces a negative control pressure from a port in the intake passage to the control valve. A pressure chamber is interposed between the constriction and the control valve, which pressure chamber has a pressure which is substantially equal to atmospheric pressure when the control valve is opened and to that in the exhaust passage when the control valve is closed. A first operating valve opens the negative control pressure passage to the atmosphere when the pressure in the pressure chamber becomes substantially atmospheric. A second operating valve, which is responsive to the amount of sucked air flowing through the intake passage, opens the negative control pressure passage to the atmosphere when the pressure in the intake passage exceeds a predetermined negative pressure.

CARBON MONOXIDE

REFER ALSO TO CITATION(S) 34945, 35500, 35514, 35528, 35532

35534 Exhaust gas purifying system for an internal combustion engine. Hanaoka, M. (to Toyota Jidosha Kogyo Kabushiki Kaisha). US Patent 4,075,837. 28 Feb 1978. Priority date 18 Jun 1975, Japan. 6p.

An improved exhaust gas purifying apparatus for an internal combustion engine is described. One of the engine cylinders is provided with a suction conduit and an exhaust conduit which are separate from a main intake manifold and a main exhaust manifold which are connected to the remaining cylinders. The suction conduit is connected to a sub-carburetor, while the main intake manifold is connected to a main carburetor. The sub-carburetor includes a throttle valve mounted on a shaft on which a throttle valve in the main carburetor is mounted. The apparatus further includes fuel control means connected to the sub-carburetor for controlling supply of fuel through the separate suction conduit in response to a negative pressure prevailing in the main intake manifold. The separate exhaust conduit has a plurality of outlets opening into the main exhaust manifold. The fuel control means is operable to establish from time to time the condition under which the fluid flowing through the sub-carburetor and one cylinder into the main exhaust manifold consists only of air, of which the quantity is proportional to that of the exhaust gas delivered from the remaining cylinders.

35535 Catalytic converter for removing noxious components from a gaseous stream. Morgan, C.R. Jr.; Snyder, P.W. Jr. (to Mobil Oil Corp.). US Patent 4,072,471. 7 Feb 1978. Filed date 28 May 1974. 10p.

A catalytic converter for use in a gaseous stream comprises cylindrical segments of monolithic ceramic impregnated with catalytically active materials, such as hydrocarbon and carbon monoxide conversion catalysts, axially spaced apart by greater than ¼ inch within a cylindrical metal container. The container has a gas inlet upstream from the spaced-apart segments and a gas outlet downstream and spaced-apart protruding fins attached to the outer circumference.

35536 Apparatus for controlling secondary air for cleaning exhaust gases. Yoshimura, T.; Matsuda, M. (to Honda Giken Kogyo Kabushiki Kaisha). US Patent 4,070,829. 31 Jan 1978. Priority date 13 Aug 1975, Japan. 12p.

An apparatus cleans the exhaust gases of a motorcycle by feeding secondary air to the exhaust path of the engine. The amount of secondary air fed is controlled in proportion to the speed of the motorcycle. The apparatus includes a control valve which is operated to be opened and closed in response to the opening and closing of the throttle valve of a carburetor of the engine.

SULFUR DIOXIDE

REFER ALSO TO CITATION(S) 34945

HYDROCARBONS

REFER ALSO TO CITATION(S) 35500, 35518, 35528, 35532, 35534, 35535, 35536

35537 Device and method for recycling hydrocarbon vapors of I.C.E. vehicles. Barres, R. (to Regie Nationale des Usines Renault). US Patent 4,070,828. 31 Jan 1978. Priority date 15 Jan 1975, France. 4p.

A novel method and means are described for recycling to the carburetor the hydrocarbon vapors emitted by a motor vehicle. Between the fuel tank and the pipe connecting the air filter to the carburetor, a container or canister is used for adsorbing the hydrocarbons. The hydrocarbons thus adsorbed by a suitable material contained in the canister are desorbed by using a stream of air under pressure from a pump, for example the anti-pollution pump provided for injecting fresh atmospheric air into the exhaust system of the vehicle.

ALTERNATIVE FUELS

REFER ALSO TO CITATION(S) 34691, 34695

35538 Critical analysis of the performance of molybdenum compounds in motor vehicles. Braithwaite, E.R. (Climax Molybdenum Co. Ltd., London); Greene, A.B. *Wear;* **46**: No. 2, 405-432(Feb 1978).

The potential role of molybdenum-containing compounds in assisting energy conservation in transport systems is discussed. The importance of frictional losses in the major units of motor vehicles is assessed and the ability of molybdenum-containing compounds to reduce such losses in practice is illustrated. Improvements of 3 percent in engine efficiency and up to 4 percent in final drive efficiency are possible. Other frictional reductions in other drive line components are also possible as a result of using molybdenum-containing compounds.

MATERIALS

35539 (UCRL—50028-77-4) **H-division quarterly report, October—December 1977.** (California Univ., Livermore (USA). Lawrence Livermore Lab.). 10 Feb 1978. Contract W-7405-ENG-48. 33p. Dep. NTIS, PC A03/MF A01.

The Theoretical EOS Group develops theoretical techniques for describing material properties under extreme conditions and constructs equation-of-state (EOS) tables for specific applications. Work this quarter concentrated on a Li equation of state, equation of state for equilibrium plasma, improved ion corrections to the Thomas—Fermi—Kirzhnitz theory, and theoretical estimates of high-pressure melting in metals. The Experimental Physics Group investigates properties of materials at extreme conditions of pressure and temperature, and develops new experimental techniques. Effort this quarter concerned the following: parabolic projectile distortion in the two-state light-gas gun, construction of a ballistic range for long-rod penetrators, thermodynamics and sound velocities in liquid metals, isobaric expansion measurements in Pt, and calculation of the velocity—mass profile of a jet produced by a shaped charge. Code development was concentrated on the PELE code, a multimaterial, multiphase, explicit finite-difference Eulerian code for pool suppression dynamics of a hypothetical loss-of-coolant accident in a nuclear reactor. Activities of the Fluid Dynamics Group were directed toward development of a code to compute the equations of state and transport properties of liquid metals (e.g. Li) and partially ionized dense plasmas, jet stability in the Li reactor system, and the study and problem application of fluid dynamic turbulence theory. 19 figures, 5 tables. (RWR)

35540 Accuracies of numerical solution methods for the elastic-perfectly plastic model. Krieg, R.D.; Krieg, D.B. (Sandia Lab, Albuquerque, NM). *J. Pressure Vessel Technol.;* **99**: No. 4, 510-515(Nov 1977).

METALS AND ALLOYS

REFER ALSO TO CITATION(S) 34469, 35073

35541 (LBL—6016) **Materials and Molecular Research Division annual report, 1976.** (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 1976. Contract W-7405-ENG-48. 450p. Dep. NTIS, PC A19/MF A01.

Separate abstracts were prepared for the individual sections of this report.

35542 (LBL—6016, pp 5-39) **Heavy element research.** 1976. In Materials and Molecular Research Division annual report, 1976.

Heavy element research activities in metallurgy and ceramics during 1976 at Lawrence Berkeley Laboratory are reviewed. Topics include: microstructure, properties and alloy design; ceramic alloy program; high resolution and high voltage electron microscopy; and powder metallurgy. (GHT)

35543 (LBL—6016, pp 40-88) **Mechanical properties.** 1976. In Materials and Molecular Research Division annual report, 1976.

Mechanical properties research in metallurgy and ceramics during 1976 at Lawrence Berkeley Laboratory are reviewed. Topics covered include: theoretical problems in alloy design; fundamentals of alloy design; and relations between dislocations, point defects, and properties of metals. (GHT)

35544 (ORNL—5309) **Liquid Metal Fast Breeder Reactor Materials Development Program. Quarterly progress report for period ending March 31, 1977.** Peterson, S. (comp.). (Oak Ridge National Lab., Tenn. (USA)). Nov 1977. Contract W-7405-ENG-26. 296p. .

LMFBR materials programs conducted or overseen by the ORNL Metals and Ceramics Division are reported. Major areas of interest include the following: steam generator materials development (steam-side/water-side corrosion--the effect of heat flux on the corrosion of $2^1/_4$ Cr—1 Mo steel by superheated steam, mechanical properties of steam generator materials, nondestructive testing), alternate LMFBR structural materials (advanced ferritic alloys development for LMFBR steam generators, alloy 800 development for advanced LMFBR steam generators), joining technology development (welding development and mechanical testing of weldments for stainless steel components, high-temperature structural design data for austenitic stainless steel weldments, hardfacing development for valves and bearings, basic welding and brazing research--examination of 16-8-2 simulated welds, advanced transition joints), piping and fitting development (including technology of transition joints), and advanced absorber materials (characterization of advanced materials, irradiation testing, performance analysis). Seventeen contributions with significant amounts of data are abstracted separately. (RWR)

35545 Zirconium and its applications in the nuclear industry. Armand, M.; Charquet, D.; Syre, R.; Tricot, R. (Ugine-Aciers, Fr). *Rev. Metall. (Paris);* **74**: No. 8-9, 471-482(Aug-Sep 1977). (In French).

This paper is a short monograph on zirconium. The discussion covers winning the metal from the ore, processing the metal and alloys, characteristic features of its metallography, properties such as corrosion resistance in water and steam, creep resistance and other mechanical properties, and behavior when irradiated. Application as atomic fuel cans in pressurized water, boiling water, and heavy water reactors and other applications by the nuclear industry are emphasized. 22 refs.

35546 1977 National Powder Metallurgy Conference proceedings. Mocarski, S.; Pietrocini, T.W. (eds.). Princeton, NJ; Metal Powder Industries Federation (1977). 283p. (CONF-7705105—). .

From National powder metallurgy conference; Detroit, MI, USA (24 May 1977).

Of the fourteen papers presented at the conference, two were prepared for inclusion into the data base. (GHT)

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 34748, 35072, 35166, 35419, 35469, 35560, 35563, 35576, 35597, 35599, 35608, 35614, 35654, 35655, 36345

35547 (BDX—613-1709(Rev.)) **Development of plating thickness standards. Milestone report.** Russell, R.J. (Bendix Corp., Kansas City, Mo. (USA)). Jan 1978. Contract EY-76-C-04-0613. 24p. Dep. NTIS, PC A02/MF A01.

Standards which are unavailable from the National Bureau of Standards were developed to support the nondestructive measurement of plating thickness. Their fabrication, measurement, certification, and calibration-recall schedule are discussed. Reference standards that have been put into service include aluminum/Kapton, silver/copper, tin/steel, gold/silver, cadmium/Kovar, silver/iron, rhodium/copper, and gold/ceramic. 6 figures, 3 tables.

35548 (LBL—7366) **Ductile superconducting wire through novel metallurgical techniques.** Hong, M.; Morris, J.W. Jr. (California

Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jan 1978. Contract W-7405-ENG-48. 7p. (CONF-780124—2). Dep. NTIS, PC A02/MF A01.

From Workshop on the development of superconductors for fusion power; Germantown, MD, USA (26 Jan 1978).

Ductile superconducting wires can be formed through controlled precipitation of the A15 phase from supersaturated solution in the solid state. The current research has focused on melting, homogenizing, and thermomechanically processing supersaturated solutions of Ga in V. A diagram of the rolling process is given. (SDF)

35549 (ORNL—5309, pp 105-111) **Welding development and mechanical testing of weldments for stainless steel components.** Edmonds, D.P.; Roche, T.K. Nov 1977.

In Liquid Metal Fast Breeder Reactor Materials Development Program. Quarterly progress report for period ending March 31, 1977.

304 and 316 stainless steels (SS) were welded by gas tungsten-arc and submerged arc processes with controlled-residual-element 308, 316, 16-8-2, and 17-8-2 SS used as the filler wire. Chemical compositions and ferrite numbers are reported for these welds. Creep-rupture life and ductility at 1200°F are presented for 16-8-2 and 316 SS gas tungsten-arc welds. 2 figures, 4 tables. (RWR)

35550 (ORNL—5309, pp 111-114) **High-temperature structural design data for austenitic stainless steel weldments.** Goodwin, G.M.; Brinkman, C.R. Nov 1977.

In Liquid Metal Fast Breeder Reactor Materials Development Program. Quarterly progress report for period ending March 31, 1977.

Mechanical properties of 16-8-2 submerged-arc welds in type 316 stainless steel plate were evaluated. The welds were made under conditions similar to those used for the CRBR thermal liner. Room-temperature Charpy impact tests were carried out for 16-8-2 submerged-arc welds aged at 1050 and 1200°F for 1000 and 1500 hours. The trend appears to be a decrease in average impact strength with increased aging time. 1 figure, 1 table. (RWR)

35551 (ORNL—5309, pp 133-172) **Piping and fittings.** McEnerney, J.W. Nov 1977.

In Liquid Metal Fast Breeder Reactor Materials Development Program. Quarterly progress report for period ending March 31, 1977.

Development of optimum fabrication methods for producing large-diameter (0.9 to 1.3 m), thin-walled (13 mm) austenitic stainless steel piping and fittings for LMFBR primary and secondary sodium loops is addressed. Fabrication methods were to be evaluated with respect to economic feasibility, dimensional control, and material behavior at LMFBR operating conditions. Formed-and-welded pipe and centrifugally cast-and-worked pipe are treated in considerable detail; dimensional evaluation was also performed on clamshell forged-and-welded elbows. 26 figures, 6 tables. (RWR)

35552 **Development and industrial production of special steels for the electro-nuclear industries and their effects on high quality steelmaking.** Viellard-Baron, B. (Creusot-Loire, Paris, Fr). *Rev. Metall. (Paris);* **74**: No. 8-9, 437-458(Aug-Sep 1977). (In French).

The impact of the nuclear age high quality steelmaking methods is documented by illustrating the problems involved, the answers found to solve them, and the economic effects.

35553 **Metallurgical development of heavy forgings of low alloy steels for the pressure vessels of pressurized water reactors.** Cadiou, L.; Comon, J.; Dunand-Roux, L.; Vassal, J.M.; Houssin, B. (Creusot-Loire, Paris, Fr). *Rev. Metall. (Paris);* **74**: No. 8-9, 459-470(Aug-Sep 1977). (In French).

The state of the art of producing and processing the steels used in PWR vessels is summarized and documented in charts and tables. 13 refs.

35554 **Explosive cladding with gold.** Bechtold, G.; Michael, I.; Pruemmer, R. (Ges fuer Kernforsch, Karlsruhe, Ger). *Gold Bull.;* **10**: No. 2, 34-37(Apr 1977).

This article reviews the factors governing bonding by this process and describes the successful lining of nickel-chromium steel tubular autoclaves for pressurized water reactors with a corrosion resistant layer of gold. 4 refs.

35555 **Copper deoxidation and degasing through hydrogen and nitrogen injections.** Foulard, J.; Galey, J. (l'Air Liquide Centre de Recherche Claude-DeLorme, Les Loges-en-Josas, France). pp 8p, Paper 6B7 of Hydrogen in metals. Vol. 10. Elmsford, NY; Pergamon Press Inc. (1977). (In French)

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P10.

Extensive liquid copper deoxidation is obtained by injecting pure hydrogen in a state of discrete bubbles through permeable refractory elements. This injection is followed by nitrogen injection to ensure the complete elimination of hydrogen. This duplex gas process permits one to obtain a high-density, low-oxygen-content copper. 5 figures, 1 table.

35556 **High hardenability ferrous powders for p/m forgings.** Eldis, G.T.; Diesburg, D.E.; Smith, Y.E. (Climax Molybdenum Co., Ann Arbor, MI). *Prog. Powder Metall.;* **33**: 67-86(1977).

From National powder metallurgy conference; Detroit, MI, USA (24 May 1977).

See CONF-7705105—.

Powder metallurgy forgings prepared from experimental ferrous Mn-0.7% Mo-0.9% Ni, Mn-1% Mo-1% Ni, and 1% Mo-1% Ni powders were compared with forgings of type 4600 alloy powder at 0.15 to 0.20% carbon content. Forgings produced from preforms sintered either in hydrogen at 1230 C (2250 F) or in endothermic gas at 1120 C (2050 F) were evaluated for end-quench hardenability, Charpy impact resistance and fracture toughness (K/sub Ic/). The Mn-0.7% Mo-O.9% Ni powder is equal in hardenability to the 4600 powder. The Mn-1% Mo-1% Ni powder is somewhat higher in hardenability, being approximately equal to a conventional wrought SAE 8800 steel of equivalent carbon content. The toughness properties of the experimental powder forgings compared favorably with those of the 4600 forgings, with the Charpy energy being slightly higher for the 4600 forgings and the K/sub Ic/ values being slightly higher for the experimental powder forgings.

35557 **Laser welding of titanium 6A1—4V.** Mazumder, J.; Steen, W.M. (Imperial Coll. of Science and Tech., London). pp 307-315 of Laser 77 opto-electronics. Conference proceedings. Waidelich, W. (ed.). Surrey, Eng.; IPC Science and Technology Press Limited, IPC House (1977).

From Laser opto-electronics conference; Munich, F.R. Germany (20 Jun 1977).

See CONF-7706116—.

The laser welding of titanium alloy using the B.O.C. 2 kW CO_2 laser is examined. The relationship between the main welding parameters such as laser power, welding speed, substrate thickness on fusion width, HAZ and weld properties is described and compared with heat transfer theory. The mechanical properties of the welds are evaluated together with their corrosion resistance. The structure of the weld zone is examined both optically and by electron microscope and the observed structures compared to those expected for the abrupt temperature cycle of a laser weld.

35558 (BNWL-tr—280) **Production of thin metal films by cathode sputtering.** Siegle, G. Translated from *Oberflaechentech./Metallprax.;* **21**: No. 7, 247-254(1972). 30p. Dep. NTIS, PC A03/MF A01.

After a brief introduction to the principle of cathode sputtering, we present the most important equipment configurations used to prepare thin films by this method. Then we describe the conditions under which temperature-sensitive insulating materials can also be sputtered. A comparison with other metallization methods will indicate those cases in which film production by cathode sputtering can be applied advantageously.

35559 (BNWL-tr—284) **Application of the vacuum technique to the deposition of thin films by ionic sputtering.** Brzezinska, D. Translated from *Pr. Przem. Inst. Elektron., Warsaw;* **12**: 95-110(1971). 16p. Dep. NTIS, PC A02/MF A01.

Characteristics and techniques of diode and triode sputtering are described as they apply to deposition of thin metallic films, and the advantages of sputtering over evaporation are enumerated. Details of equipment components are given and several available commercial devices are described. Brief consideration is given to the application of ionic sputtering to fabrication of microelectronic circuits. (SDF)

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 35595, 35599, 35601, 35609, 35614, 35657, 35660

35560 (BDX—613-1744(Rev.)) **Development of a metallographic method for tungsten—rhenium. Final report.** Rahe, A.H. (Bendix Corp., Kansas City, Mo. (USA)). Mar 1978. Contract EY-76-C-04-0613. 18p. Dep. NTIS, PC A02/MF A01.

A metallographic method was developed for chemical vapor deposited tungsten-rhenium alloys consisting of a two-phase structure of β solid solution and a finely dispersed A-15 or federite phase. This method provides fast and reliable information on the structure and composition of the CVD deposit.

35561 (LBL—6016, pp 290-291) **Electron paramagnetic resonance.** Myers, R.J. 1976.

In Materials and Molecular Research Division annual report, 1976.

Research activities in electron paramagnetic resonance at Lawrence Berkeley Laboratory during 1976 are described. Topics covered include high-field nuclear magnetic resonance spectroscopy

on C-13 and other nuclei; electron paramagnetic resonance spectroscopy on transition metal complexes; and electron paramagnetic resonance spectra of substituted cyclooctatetraene radical ions. (GHT)

35562 (ORNL—5255, pp 357-366) **Creep studies in stainless steels.** Ajaja, O.; Ardell, A.J. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

TEM observations were made on the creep microstructures of cold-worked type 304 stainless steel. Creep tests were stopped at various stages of creep to investigate substructures. Curves are presented for tests at 760°C and 69 MN/m² for specimens prestrained 0, 4, and 10 percent. Effects of cold working are noted. In all cases grain boundary precipitates were observed after 24 hours of creep. Later, some tiny dark spots appeared; these presumably were fine intragranular carbides nucleated on dislocations. 5 figures, 1 table. (RWR)

35563 (ORNL—5255, pp 368-376) **Metallurgical characterization of prototypic tubesheet forging.** Offer, H.P. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

Study of vacuum-arc-remelted 2¼ Cr—1 Mo steel tubesheet for the CRBR steam generator is reported. The microstructure resulting from heat treatment is shown; proeutectoid ferrite is the predominant phase. The flow pattern of the metal during closed-die, hot forging is represented schematically. Results of an inclusion content determination are tabulated. 3 figures, 1 table. (RWR)

35564 Local environment effects in disordered alloys. Cable, J.W. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Appl. Phys.;* **49**: No. 3, 1527-1531(Mar 1978).

The magnetic moment of an atom in a ferromagnetic disordered alloy depends on the local environment of that atom. This is particularly true for Ni and Pd based alloys for which neutron diffuse scattering measurements of the range and magnitude of the moment disturbances indicate that both magnetic and chemical environment are important in determining the moment distribution. In this paper we review recent neutron studies of local environment effects in Ni based alloys. These are discussed in terms of a phenomenological model that allows a separation of the total moment disturbance at a Ni site into its chemical and magnetic components.

35565 Spin dynamics and magnetic ordering in mixed valence systems. Shapiro, S.M.; Moller, H.B.; Axe, J.D.; Birgeneau, R.J.; Bucher, E. (Brookhaven National Laboratory, Upton, New York 11973). *J. Appl. Phys.;* **49**: No. 3, 2101-2106(Mar 1978).

Neutron scattering measurements are reported on the mixed valence compounds Ce/sub 1-x/Th/sub x/ and TmSe. The chi" (Q,ω) as derived from the inelastic spectra of Ce/sub 0.74/Th/sub 0.26/ shows a peak in the γ phase near 20.0 meV and shifts abruptly to greater than 70.0 meV at the transition to the α phase. The temperature independence of the susceptibility within the γ phase cannot be simply reconciled with the temperature dependence of the valence within the γ phase. TmSe is shown to order in a type I antiferromagnetic structure below T/sub N/~3.2 K. The magnetic phase diagram is understood as a successive domain reorientation and a metamagnetic phase transition for $T<3$ K with increasing field. The mixed valence nature manifests itself in a reduced moment and a markedly altered crystal field. Another sample of TmSe with a lattice parameter implying 100% Tm^{3+} exhibits spin correlations characteristic of a type II structure but never achieves long range order.

35566 Field induced magnetic form factor of γ-Ce. Stassis, C.; Loong, C.; Kline, G.R.; McMasters, O.D.; Gschneidner, K.A. Jr. (Ames Laboratory—USDOE, and Departments of Physics and Materials Sciences and Engineering, Iowa State University, Ames, Iowa 50011). *J. Appl. Phys.;* **49**: No. 3, 2113-2114(Mar 1978).

In the present experiment polarized neutron scattering techniques have been used to assess the spatial distribution and temperature dependence of the magnetization induced in a single crystal of γ-Ce by a magnetic field of 60 kG. The measured form factor is found to be in agreement with the free ion 4f magnetic form factor of Ce^{3+}. Comparison of the localized susceptibility, obtained in the present experiment, with bulk susceptibility measurements indicate that there is a rather large positive conduction electron contribution to the static susceptibility of γ-Ce. The localized moment is found to follow, between 300 and 115 K, a Curie-Weiss law with a paramagnetic Curie temperature of (-44 +- 2.5) K. The measurements indicate that at approximately 100 K some ions of the γ-Ce crystal undergo a change in their electronic configuration.

35567 Magnetic ordering in Ce-La and Nd-La alloys. Petersen, T.S.; Legvold, S.; Gschneidner, K.A. Jr.; Tsang, T.E.; Moorman, J.O. (Ames Laboratory: DOE and Departments of Physics and Materials Science and Engineering, Iowa State University, Ames, Iowa 50011). *J. Appl. Phys.;* **49**: No. 3, 2115-2117(Mar 1978).

Heat capacity, magnetic susceptibility, and electrical resistivity measurements have been made on a wide ranging set of Ce-La and Nd-La alloys. In the case of Ce it is found that less than 5 at. % of La will prevent the β (dhcp) to α (collapsed fcc) transition at T9 or ≈50 K. In the case of Nd-La only the dhcp allotrope is formed. Two magnetic ordering temperatures have been found for many of the samples. These are believed to be caused by antiferromagnetic ordering on the two different atomic sites in the dhcp structure, cubic and hexagonal. In both sets of alloys the two ordering temperatures coalesce into one for La concentrations > or ≈30%. Additional magnetic features in Ce-La alloys are explained by the formation of the fcc phase.

35568 Spin-wave temperature dependence of gadolinium. Grobsky, K.; Harmon, B.N. (Ames Laboratory: DOE and Physics Department, Iowa State University, Ames, Iowa 50011). *J. Appl. Phys.;* **49**: No. 3, 2147-2149(Mar 1978).

Previous theoretical studies of the temperature dependence of the magnon dispersion curves of rare earth metals have usually considered only the renormalization due to spin-wave interactions and the effect of temperature variations of the magnetocrystalline anisotropy. An important consideration which has not been included in these studies is the possible temperature dependence of the exchange coupling between the localized spins. Taking into account only the shorter conduction electron mean free path and the resulting decrease in the 4f-4f coupling as T increases we can qualitatively understand the general features of the measured magnon dispersion curves. Our results are consistent with recent measurements on Gd alloys which relate the temperature dependence of the magnetic ordering temperature to the conduction electron mean free path.

35569 Calculation of the effect of supercharging on hydrogen and hydride distribution in a thermal gradient in Zircaloy. Bilsby, C.F. (UKAEA Reactor Group, Springfields). *J. Nucl. Mater.;* **68**: No. 1, 1-8(Sep 1977).

The distribution of corrosion hydrogen in a temperature gradient in Zircaloy sheet is calculated by a finite difference method based on a supercharging mechanism proposed by Marino. The distribution of dissolved hydrogen and of hydride is found to depend approximately on J_0/β, where J_0 is the rate of influx of hydrogen and β describes the efficiency of the hydride particles as sinks for hydrogen. The connection of dissolved hydrogen in equilibrium with hydride shows marked segregation toward cooler regions for all J_0/β values investigated, whereas for J_0/β approximately 10^{-3}ppm.mm²/s the hydride distribution is uniform. For β approximately 10^{-4}/mm, considered applicable to water-reactor cladding, calculations indicate that the dissolved hydrogen will not precipitate as hydride for any practical rate of cooling. A further consequence of the model is that enhanced hydride precipitation will occur in regions where there is overheating or a change in J_0.

35570 Structure of tungsten and molybdenum films deposited from the gas phase in the low-temperature pyrolysis of carbonyls. Semiletov, S.A.; Imamov, R.M.; Zav'yalova, A.A.; Kachurina, E.E.; Sukhodreva, I.M.; Anokhin, B.G. (Institute of Crystallography, Academy of Sciences, USSR). *Sov. Phys. - Crystallogr. (Engl. Transl.);* **22**: No. 5, 602-605(Sep 1977).

The structure of thin films of refractory metals (W, Mo), deposited from the gas phase by pyrolysis of the corresponding carbonyl vapors at 300—400° C, was studied by x-ray structure and electron-diffraction methods of analysis. It was shown that low-temperature pyrolysis produces a metastable fcc phase, i.e., an interstitial solid solution of variable composition (berthollide phase). Structural transformations in the films during subsequent heat treatment were investigated experimentally. On annealing at 600—800° C, the fcc phase decomposes to form, in the case of W, a bcc lattice with the period....., characteristic of the pure metal, and in that of Mo, the hexagonal molybdenum carbide Mo_2C. The difference in behavior of Mo and W films on heat treatment is due to the different carbon contents in the initial films (4.2—4.7 wt.% for Mo and 0.7—0.9 wt.% for W according to data of vacuum-chromatographic analysis).

35571 Effect of hydrogen on the austenite to martensite transformation in steel. Iyer, K.J.L.; Ramachandran, E.G. (Indian Inst. of Tech., Madras). pp 7p, Paper 3B4 of Hydrogen in metals. Vol. 9. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P9.

By introducing hydrogen cathodically into a 1%C, 2% Mn steel in its austenitic condition, the stabilizing effect of hydrogen on the austenite—martensite transformation was clearly demonstrated. The stabilization is satisfactorily explicable on the basis of the deactivation of the strain embryos in the austenite by hydrogen. 1 figure, 1 table.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 35005, 35549, 35550, 35556, 35642, 35643, 35655, 35659

35572 (ANL—77-72) **Cyclic-deformation resistance of weld-deposited Type 16-8-2 stainless steel at 593°C.** Raske, D.T. (Argonne National Lab., Ill. (USA)). Aug 1977. Contract W-31-109-ENG-38. 37p. .

The creep fatigue and cyclic-deformation behavior of Type 16-8-2 (16 percent Cr-8 percent Ni-2 percent Mo) stainless steel weld metal is discussed. Tests were conducted in air at 593°C and a strain rate of 4×10^{-3} s^{-1}. Comparisons with data for Type 316 stainless steel base metal indicate that the weld metal has significantly longer fatigue lives for 360-, 1.8×10^{3}-, and 1.8×10^{4}-s tension hold-time tests. This longer life is attributed to the fine duplex microstructure of the weld metal that inhibits the growth rate of cracks. Additional studies on the cyclic-deformation behavior of the weld metal indicate that this material is strain-history dependent; therefore, a unique cyclic stress—strain curve does not exist. Monotonic tension tests after cyclic straining result in a different stress—strain curve from that obtained from companion fatigue tests at various completely reversed constant strain ranges. A comparison of the fracture morphology of creep-fatigue and creep-rupture specimens indicates that differences resulting from these tests can be attributed to different failure mechanisms. 32 figures, 5 tables.

35573 (LBL—7381) **Wear resistant alloys for coal handling equipment. Progress report, January 1—September 30, 1977.** Bhat, M.S.; Zackay, V.F.; Parker, E.R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 1977. Contract W-7405-ENG-48. 130p. Dep. NTIS, PC A07/MF A01.

The in-service operating conditions of coal transport and fragmentation equipment involve various combinations of dry or liquid slurry abrasion, impact loading, and temperatures that may vary from ambient to elevated (500°F—1000°F). Both 2-body and 3-body abrasive wear can be encountered. The published literature contains little information on testing materials under the various abrasive conditions that are of concern, especially 3-body wear. However, a number of tests were identified which may serve to provide wear data under different service conditions. A dry abrasive wear tester, to be used for screening alloys, was constructed. A review of the alloy steel literature was completed and was used to select low-alloy and secondary hardening steel compositions for screening. Initial screening criteria included the stipulation of a hardness of R/sub c/55 with an impact toughness of around 15 ft lbs or a fracture toughness of 80 KSIVin., depending on the application being considered. Several of the steels that were evaluated to date appeared to meet these criteria. A systematic development of secondary hardening steels has been evolved and it has been shown that good combinations of strength and toughness were achieved through proper composition and microstructural control. These higher alloyed steels appear to be suited for long-term, elevated-temperature service. The lower alloy Cr-Ni-Mo and Cr-Si-Mo steels investigated also exhibited good combinations of strength and toughness and may be suitable for ambient temperature use.

35574 (ORNL—5255) **Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.** Hill, M.R. (comp.). (Oak Ridge National Lab., Tenn. (USA)). Mar 1977. Contract W-7405-ENG-26. 452p. .

This report presents results of all structural materials mechanical properties test programs sponsored by the Reactor Development and Demonstration and the Nuclear Research and Applications Divisions of the Energy Research and Development Administration. Investigations by nine organizations are included. Separate abstracts were prepared for 33 of the contributions to this volume. (RWR)

35575 (ORNL—5255, pp 2-10) **Mechanical property program of Alloy 718.** Korth, G.E.; Smolik, G.R. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

Creep—rupture tests were performed on several heats given the conventional (1750°F) heat treatment. Elongation and time to rupture are tabulated for tests at 1200, 1350, and 1400°F; also rupture life is plotted vs stress. 0.2% yield stress, ultimate tensile strength, and elongation are tabulated for room-temperature tensile test data. Tests were conducted to determine which type of strain-controlled loading is the most damaging to alloy 718 in a creep—fatigue test. Results on stresses, cycles to failure, time to failure, etc., are tabulated. 2 figures, 4 tables. (RWR)

35576 (ORNL—5255, pp 11-28) **Low-cycle fatigue of Type 16-8-2 stainless steel ASA weld metal.** Raske, D.T. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

Data on the suitability of type 16-8-2 stainlss steel as a filler metal for joining type 316 stainless steel in the fabrication of the CRBRP thermal liner were obtained. Continuous-cycling and 360-s tension hold-time fatigue tests on weld specimens are reported; tests were conducted in air at 593°C and a strain rate of 4×10^{-3} s^{-1}. Stresses and fatigue life are tabulated. Fatigue properties and cycle life were better than those of type 316 stainless steel. Monotonic 0.2% offset yield strength is higher in root weld metal than surface weld metal; however, the elastic moduli of samples from the two locations are the same. 8 figures, 2 tables. (RWR)

35577 (ORNL—5255, pp 28-36) **Application of damage-rate approach to creep-fatigue life prediction analysis in different heats of Type 304 stainless steel.** Maiya, P.S.; Majumdar, S. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

The damage-rate approach and its use are briefly summarized. Stress-relaxation data from hold-time experiments on three heats of type 304 stainless steel are tabulated. Calculated fatigue life is plotted vs the experimental value for tensile and compressive hold-time tests. Time to rupture is shown as a function of plastic strain rate. 4 figures, 1 table. (RWR)

35578 (ORNL—5255, pp 35-49) **Interpretation of high-temperature creep of Type 304 stainless steel.** Chopra, O.K.; Natesan, K. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

Second-stage creep behavior of type 304 stainless steel is evaluated in terms of a theory incorporating both dislocation-glide and recovery creep theories of steady-state creep. The applied stress dependence of the creep rate is examined in terms of the measured effective and internal stresses. The observed value of apparent activation energy is related to the true activation energy for the rate-controlling process for high-temperature creep. 9 figures, 2 tables. (RWR)

35579 (ORNL—5255, pp 50-56) **Influence of sodium environment on the low-cycle fatigue behavior of austenitic stainless steel.** Smith, D.L.; Zeman, G.J. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

The creep—fatigue interaction of annealed type 304 stainless steel at 600°C was investigated. Low-frequency fatigue tests were conducted at a strain rate of 4×10^{-5} s^{-1} in sodium that contained 0.3 ppM carbon. For a total strain range of 1.1%, the fatigue lifetime was a factor of 2 lower than at 4×10^{-3} s^{-1}. However, no effect of strain rate was observed at 0.94% strain range. Substantial differences in the plastic strain-range behavior were observed for the two rates. 2 figures. (RWR)

35580 (ORNL—5255, pp 58-64) **Flow and failure criteria: influence of strain rate and test temperature on ductility of Types 304 and 316 stainless steel.** Sikka, V.K.; Stephenson, R.L. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

Three-dimensional and isothermal plots are presented for uniform and total elongation and reduction of area for annealed type 316 stainless steel. The tensile strain rate varied over six orders of magnitude, and the test temperature ranged from 0 to 800°C. The observed quantities all showed high values, essentially independent of test temperature. 6 figures. (RWR)

35581 (ORNL—5255, pp 65-67) **Complex materials behavior studies in support of design methods data list using reference heats: compressive creep of 16-mm (5/8-in.) plate of Type 316 stainless steel reference heat.** Sikka, V.K.; Baldwin, R.H. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

Problems in compressive creep testing are mentioned. An axial specimen of 0.25 in. diameter and 0.40 in. length was loaded to 15.5 ksi at 1100°F. Compressive strain—time data are plotted, and a photograph of the specimen after testing is shown. 3 figures. (RWR)

35582 (ORNL—5255, pp 67-90) **Mechanical property characterization of Type 316 stainless steel reference heat.** Sikka, V.K.; Baldwin, R.H.; Patton, E.B. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

Pipes, plates, and bars were reannealed at 1950°F for 0.5 h, then tensile tested at 77, 400, 800, 1100, and 1200°F at a strain rate of 0.0044/min. 0.2% yield stress, ultimate tensile strength, uniform and total elongation, and reduction of area are plotted, tabulated, and discussed for the various test temperatures. Reannealing lowered the yield strength, while ultimate tensile strength was not significantly affected. Data are also presented for each form from creep testing at 1100°F and 35.0 ksi; average time to rupture was 398 h. Tensile properties of 5/8-in. plates were measured for strain rates ranging from 0.22 to 0.00044 min^{-1}; temperature dependence of yield stress, ultimate tensile stress, elongation, and reduction of area are reported for the various strain rates. 18 figures, 5 tables. (RWR)

35583 (ORNL—5255, pp 90-97) **Elastic properties of engineering construction materials.** Hammond, J.P. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

The dynamic elastic constants were determined for 9 Cr—1 Mo steel plate from 24 to 649°C (75 to 1200°F) by acoustical methods. Also, the static Young's moduli at room temperature were determined for mild carbon steel and Inconel 718 by use of a mechanical extensometer fitted with the LVDT strain sensors. The latter day may be used as the "X_6" values in the cubic polynomicals for representing Young's modulus as a function of temperature for these alloys. Results for 9 Cr—1 Mo steel were compared with those for 2¼ Cr—1 Mo steel. 1 figure, 5 tables. (RWR)

35584 (ORNL—5255, pp 97-100) **Inconel alloy 718 mechanical and physical property program.** Roche, T.K.; Feltner, J.C. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

Creep—rupture tests were carried out from 1000 to 1400°F for stresses up to 150 ksi. Rupture time, elastic and plastic strains, and creep rate are tabulated. Temperature dependence of rupture properties was indicated. 1 figure, 1 table. (RWR)

35585 (ORNL—5255, pp 101-120) **Mechanical and metallurgical behavior of weldments for LMFBR.** Goodwin, G.M.; Brinkman, C.R. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

(I) Creep—rupture properties of type 16-8-2 stainless steel submerged-arc weld specimens with type 316 stainless steel base metal were measured. (II) Creep—rupture tests of CPF8 and CPF8M centrifugally cast pipe were performed at 1000 and 1200°F; data on strain, time to rupture, etc., are tabulated. Ductility at rupture and creep strain to rupture are plotted. (III) Tangential modulus of elasticity was determined for CPF8 and CPF8M piping, along with elastic compliance matrices. The results showed the importance of considering anisotropy in stress analyses for these materials. (IV) Variation of ultrasonic velocities with orientation in a multipass Inconel 82 weldment was measured. Both longitudinal and shear wave velocities vary by significant percentages in some planes. 14 figures, 5 tables. (RWR)

35586 (ORNL—5255, pp 130-135) **Heat-to-heat variation of 2 1/4 Cr—1 Mo steel.** Klueh, R.L. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

The 0.2% yield strength and ultimate tensile strength are plotted for 12 heats of 2¼ Cr—1 Mo steel in laboratory isothermally annealed condition. The dominant characteristic of the data is the dynamic strain aging peak when the ultimate tensile strength is given as a function of temperature. Much of the discussion on the differences between heats is centered on dynamic strain aging and possible reasons for differences in behavior of the different heats. 1 figure, 1 table. (RWR)

35587 (ORNL—5255, pp 135-139) **Thermal aging effects on 2 1/4 Cr—1 Mo steel.** Klueh, R.L. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

Room-temperature and aging-temperature tensile properties of aged commercial tubing heats of 2¼ Cr—1 Mo steel are tabulated for 850, 950, and 1050°F and aging times up to 5000 hours; properties included are yield, ultimate, and fracture strength, uniform and total elongation, and reduction of area. This material is to be used in the CRBR steam generators. 1 figure, 3 tables. (RWR)

35588 (ORNL—5255, pp 139-188) **Interim analysis of the creep strain—time characteristics of annealed and isothermally annealed 2 1/4 Cr—1 Mo steel.** Booker, M.K. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

Constant-load isothermal creep strain—time data were analyzed over a range of stresses and temperatures to yield an expression for creep strain as a function of stress, time, and temperature. The equations contain terms involving elevated-temperature ultimate tensile strength, which greatly decrease the uncertainty in predictions caused by the large variations in the properties of the material due to heat treatment and heat-to-heat variations. This equation is recommended for use in the design of the CRBR steam generator. The analysis indicated that this material has two different creep mechanisms. 28 figures, 5 tables. (RWR)

35589 (ORNL—5255, pp 188-197) **Mechanical properties of transition joint materials in support of LMFBR steam generator design.** Brinkman, C.R.; King, J.F.; Strizak, J.P.; Klueh, R.L.; Booker, M.K. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

The area of primary concern requiring extensive characterization is the HAZ in the 2¼ Cr—1 Mo steel adjacent to the weld metal. Comparisons of the tensile properties obtained from annealed 2¼ Cr—1 Mo steel aged and tested at 510°C (950°F) indicate that aging reduces the ultimate tensile strength. The possibility of other aging effects at this temperature in the HAZ due to carbon depletion or precipitation of intermetallic phases or carbides needs to be investigated. Interim results of creep—rupture tests conducted on some of the various heat treatments (microstructures) possible across the HAZ are compared with similar all-weld-metal data. Annealed 2¼ Cr—1 Mo steel has the lowest creep—rupture strength but highest ductility at 510°C (950°F). Comparisons of interim individual material cyclic properties are given, including strain-controlled fatigue, cyclic stress—strain, and creep—fatigue interaction. The as-deposited ERNiCr-3 exhibited the highest cyclic strength and high-cycle fatigue resistance of the materials compared. 8 figures, 1 table. (RWR)

35590 (ORNL—5255, pp 197-204) **Creep and tensile properties of transition weld joint materials.** Klueh, R.L.; King, J.F. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

Joining the CRBR intermediate heat exchanger to the steam generator will require several joints, one of which will use Inconel 82 as a filler metal. Tensile properties of Inconel 82 weld metal (yield, ultimate, and fracture strengths, uniform and total elongations, and reduction of area) were determined for several plates at temperatures up to 1350°F. Analytical chemical results revealed that iron varied significantly across the cross section of the sample analyzed. The creep-rupture behavior of Inconel 82 weld metal is also briefly discussed. 4 figures, 2 tables. (RWR)

35591 (ORNL—5255, pp 205-222) **High-temperature design.** Corum, J.M.; Pugh, C.E. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

Uniaxial deformation studies on type 304 stainless steel emphasized nonsteady loading conditions including cyclic creep, reversal creep, and creep-plasticity interactions. Data obtained include tensile properties of specimens after discontinued creep, strain cycling behavior of specimens after discontinued creep, creep behavior of specimens after discontinued strain cycling, relaxation behavior during strain cycling, and creep behavior after interspersing of plasticity and creep strains of various types. Testing temperatures were 900, 1000, and especially 1100°F. Constant-strain-rate tests on type 316 stainless steel at 1100°F covered rates from 2.7×10^{-1} to 1.1×10^{-8} s^{-1}; stress - strain data are plotted. Cyclic hardening behavior of 316 SS at room temperature is exhibited, as are transient creep strain and plastic plus transient creep strain vs stress at 1100°F. Uniaxial and biaxial rupture data for type 304 stainless steel at 1100°F are compared. Axial and circumferential creep strains in constant-load biaxial rupture tests are shown. 22 figures. (RWR)

35592 (ORNL—5255, pp 223-240) **Mechanical properties of HTGR steam generator and primary circuit materials.** DiStefano, J.R.; Brinkman, C.R. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

Tensile properties of Hastelloy X and Inconel 617, unaged and aged for 2500 h at 1000, 1300, and 1600°F in argon, are tabulated; 0.2 percent yield strength, ultimate tensile strength, elongation, and reduction of area are included. Micro-structure studies showed precipitation. Results from creep tests on 2¼ Cr—1 Mo steel and Hastelloy X at 900 to 1200°F and 1200 to 1600°F, respectively, in helium and air are given; rupture life seemed to vary widely. Tensile creep—fatigue data are plotted for 2¼ Cr—1 Mo steel at 1000°F. Some data on inelastic strain components and failure lifetimes for Hastelloy X at 1600°F are reported. 9 figures, 5 tables. (RWR)

35593 (ORNL—5255, pp 240-259) **Fatigue studies in support of the ISX.** Corwin, W.R. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

Two types of fatigue tests were performed on Cu—1.08 percent Cr. Test conditions (77 and 150°F) and results for uniaxial fatigue are tabulated; fully reversed load-controlled fatigue tests were also conducted. Cyclic softening and tensile rachetting were observed. Effect of stress concentration on fatigue life is also shown. 3 figures, 3 tables. (RWR)

35594 (ORNL—5255, pp 261-270) **Creep crack growth in Alloy 718.** Sadananda, K.; Shahinian, P. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

Creep crack growth behavior was studied at 1000, 1200, and 1400°F in an 18.8-mm-thick plate of Alloy 718. Data were analyzed to yield crack propagation rate as a function of stress intensity. Time to failure is presented as a function of initial stress intensity. It was concluded that creep crack growth occurs by grain boundary diffu-

sion at 1000 to 1200°, but by deformation for temperatures above 1400°. 4 figures, 1 table. (RWR)

35595 (ORNL—5255, pp 270-277) **Fatigue crack propagation in Alloy 718: effect of heat treatment on microstructure and fatigue behavior.** Smith, H.H.; Michel, D.J. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

Fatigue crack propagation of Alloy 718 was investigated at 1100°F. Optical micrographs of microstructure and SEM examinations of fracture surfaces are presented. 3 figures, 2 tables. (RWR)

35596 (ORNL—5255, pp 279-287) **Deformation of pressurized tubes of 316 SS and Alloy 718.** Blackburn, L.D.; Steichen, J.M. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

Pressurized tube specimens of stainless steel 316 were tested at 900 to 1200°F at hoop stresses as high as 28.1 ksi. Corresponding numbers for Alloy 718 specimens were 700 to 1100°F and 77 ksi. Data for ambient temperature pressurization and hoop strain results for pressurized tubes after thermal exposure are tabulated. There is considerable scatter in the results. 5 tables. (RWR)

35597 (ORNL—5255, pp 287-300) **Fatigue-crack propagation in dissimilar metal weldments.** James, L.A. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

The crack propagation of three dissimilar metal welds finding application in LMFBR was studied. The specimens employed in this study were of the ASTM "Compact Type" design (W = 2.00 in., B = 0.47 in.), and were tested on a feedback-controlled machine with load as the control parameter. The cyclic frequency and stress ratio were 40 cpm and 0.05 for all tests. Tests were conducted at 427°C (800°F) and 538°C (1000°F) in an air environment. The three combinations of dissimilar metal weldments were Inconel 600/Inconel 82/Inconel 718, Inconel 718/Inconel 82/type 316 stainless steel, and Inconel 600/Inconel 82/type 316 stainless steel. An automatic gas-tungsten-arc (GTA) welding process was employed in welding the dissimilar base metals, using Inconel 82 filler wire in each case. The results for the three types of dissimilar metal weldments, each tested at two temperatures, are given. Also shown are scatter bands typical of the behavior of the base metals tested under identical conditions of temperature, frequency, loading waveform, and stress ratio. There is very little difference in the crack growth rates at the two temperatures. Fatigue-crack growth rates in the dissimilar metal weldments did not differ appreciably from those in the base metals tested under similar conditions. 6 figures. (RWR)

35598 (ORNL—5255, pp 302-314) **Basic specimen testing.** Manjoine, M.J. (Westinghouse Research Labs., Pittsburgh). Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

Detailed data from creep testing of type 304 stainless steel (SS) are tabulated. Rupture data are shown for 1000°F, and creep rate is plotted for 1100°F. For a step-loaded test where stress is increased from a lower value after considerable exposure time, the creep rates are higher than for a continuous loading test at the higher stress level. Creep data for type 316 SS at 1100°F are also given. 2 figures, 2 tables. (RWR)

35599 (ORNL—5255, pp 314-318) **Tubular specimen testing.** Gowda, B.; Thomas, K.C. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

Most of the work concerned heat treatment of type 316 SS tubular specimens. Both heat-treated flat specimens and specimens cut from heat-treated tubular specimens were tested for tensile, hardness, and grain size properties. The heat treatment procedure with 30-minute soak time yielded the following properties: 0.2 percent yield stress, 28 to 32 ksi; ASTM Grain Size, 3 to 5; Rockwell B Hardness, 60 to 72. The variation of these three properties as a function of soak time is shown. The 30-minute soak time treatment yielded the desired properties. In addition, some testing was done on type 304 SS. 1 figure, 2 tables. (RWR)

35600 (ORNL—5255, pp 318-330) **Sodium effects on mechanical properties of structural materials.** Flagella, P.N.; Kahrs, J.; Denne, J.; Schrock, S.L. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

Results from creep rupture and low-cycle fatigue tests in flowing sodium of solution-annealed type 316 stainless steel with various pretreatments are presented. Tests were conducted at 593°C and stresses of 224.1, 248.2, and 275.8 MPa for Na exposures of 0, 2000, and 5000 hours. Results include strain on loading, hours to various percentages of creep strain, minimum creep rate, time to third-stage-creep (0.2 percent offset), time to rupture, and total elongation at rupture. Effects of frequency and tension-hold on low-cycle fatigue life of type 316 stainless steel are shown. Stress range response and effects of strain rate and tension-hold on stress range response are also plotted. 7 figures, 2 tables. (RWR)

35601 (ORNL—5255, pp 332-341) **Study on subgrain/cell development during creep deformation.** Foulds, J. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

Strain behavior of AISI 330 stainless steel at 652°C and 25 ksi applied stress is presented. Optical microscopy indicated no discernible variation in average grain size. SEM fractographs were also taken. Intergranular cracking apparently occurred. Room-temperature microhardness is plotted as a function of distance from the fracture surface for various applied stresses at 701°C. Several TEM micrographs are shown for specimens at 25 and 35 ksi. 6 figures, 1 table. (RWR)

35602 (ORNL—5255, pp 345-356) **Hot-hardness of IN-718, 706, PE-16, M-813, and correlation with ultimate tensile strength of IN-718 and PE-16.** Price, F. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

Hot-hardness tests were conducted with a Diamond Pyramid Indentor with sapphire tip in a high-purity argon atmosphere; results are tabulated to approximately 1000°C. Apparent activation energies for indentation hardness were calculated from the Larsen-Badse relation. The modulus-compensated hot-hardness of IN-718 is plotted as a function of reciprocal absolute temperature. Calculated and experimental tensile strengths of IN-718 and PE-16 are compared for various temperatures. 5 figures, 4 tables. (RWR)

35603 (ORNL—5255, pp 377-392) **Mechanical properties of decarburized 2 1/4 Cr—Mo steel in sodium.** Pizzo, P.P.; Hampton, L.V. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

The effect of decarburization of 2¼ Cr—1 Mo steel on its high-temperature mechanical properties was studied. Conditions relevant to CRBR operation were investigated. Uniaxial creep data are tabulated for 950°F testing after two different heat treatments. A thermal aging phenomenon is indicated. Biaxial creep data (time to rupture) were correlatable with uniaxial data; therefore, biaxial test results can be used to evaluate decarburization. Surface carburization was observed in a tube exposed to static sodium for 2000 hours at 950°F in a 304 SS exposure chamber. Carburization was also seen in type 316 stainless steel (SS) foils. To determine the decarburization potential of the loop sodium, foils of 316 SS and Cr—Mo steel were used; data indicated the decarburization of 2¼ Cr—1 Mo and the carburization of 316 SS. 5 figures, 3 tables. (RWR)

35604 (ORNL—5255, pp 393-410) **Mechanical properties of carburized stainless steel in sodium.** Copeland, J.F.; Pizzo, P.P.; Yuen, J.L. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

The influence of liquid sodium on fatigue crack propagation rates for annealed type 316 stainless steel and weldments for the LMFBR Intermediate Heat Transport System was studied. Testing was done at about 0.5 cycles per minute and 950°F in carbon-saturated sodium (to study carburization). Fatigue fracture surfaces of air and sodium specimens were examined with a scanning electron microscope. The carbon profiles of the crevice carburization exposure specimens were determined with an electron microprobe. Creep testing of carburized 316 H stainless stain continued; the time to rupture of the argon control specimen was approximately 2.6 times that of the carburized specimen, although creep rates were essentially equivalent. 7 figures, 3 tables. (RWR)

35605 (ORNL—5255, pp 411-423) **Fracture toughness of LMFBR steam generator materials.** Copeland, J.F.; Yuen, J.L. Mar 1977.

In Mechanical properties test data for structural materials. Quarterly progress report for period ending January 31, 1977.

Thick-section 2¼ Cr—1 Mo steel plates were preheated to represent LMFBR conditions. Ten J-integral fracture toughness specimens were tested. Fracture toughness K/sub Ic/ values, as computed from J/sub Ic/, illustrate the effects of temperature and welding on toughness. The elevated-temperature fracture toughness valves for both the base metal and the shielded metal arc weld heat affected zone (HAZ) are significantly below the room-temperature results. Fracture toughnesses at room temperature are nearly identical for the HAZ and the base material. Results for gross membrane stress for fracture initiation are plotted as functions of crack size and fracture toughness. 7 figures, 2 tables.

35606 (ORNL—5309, pp 43-64) **Analysis of the time-dependent fatigue behavior of 2 1/4 Cr—1 Mo steel based on the concept of linear summation of creep and fatigue damage.** Booker, M.K. Nov 1977.

In Liquid Metal Fast Breeder Reactor Materials Development Program. Quarterly progress report for period ending March 31, 1977.

Determination of parameters required by the model is considered first. The projected relation between strain range and cycles to failure at constant hold time is shown at 800, 900, 1000, and 1100°F; the relation between life to failure and hold period at constant strain range is also shown for the same temperatures. Elastic analysis design curves were constructed for strain range vs cycle life and cycles to failure. 24 figures, 1 table. (RWR)

35607 (ORNL—5309, pp 65-68) **Analysis of the fatigue crack growth behavior of isothermally annealed 2 1/4 Cr—1 Mo steel.** Booker, M.K.; Corwin, W.R.; Booker, B.L.P. Nov 1977.

In Liquid Metal Fast Breeder Reactor Materials Development Program. Quarterly progress report for period ending March 31, 1977.

Attempts to develop analytical models to describe crack growth are summarized. Relations between crack growth rate and effective stress intensity factor, and crack growth constant and cycle period are shown. 2 figures. (RWR)

35608 (ORNL—5309, pp 77-95) **Advanced ferritic alloys development for LMFBR steam generators.** Bryant, P.E.C. Nov 1977.

In Liquid Metal Fast Breeder Reactor Materials Development Program. Quarterly progress report for period ending March 31, 1977.

(I) Results of creep and stress rupture tests are tabulated and plotted. Deleterious effects of an Ar atmosphere were confirmed. (II) Plates were welded by the shielded metal-arc or gas tungsten-arc process. Hardness determined by Charpy V-notch impact tests is tabulated. 6 figures, 9 tables. (RWR)

35609 (ORNL—5309, pp 116-127) **Basic welding and brazing research: examination of 16-8-2 simulated welds.** Leitnaker, J.M.; Russell, K.F.; Houck, C.W.; Oliver, W. Nov 1977.

In Liquid Metal Fast Breeder Reactor Materials Development Program. Quarterly progress report for period ending March 31, 1977.

Results of Magne-Gage and hardness measurements of as-welded and aged weld metal are tabulated. Metallographic examinations revealed the presence of delta-ferrite in the starting materials. 7 figures, 1 table. (RWR)

35610 (ORNL—5309, pp 173-222) **Survey of available creep and tensile data for alloy 800H.** Booker, M.K.; Baylor, V.B.; Booker, B.L.P. Nov 1977.

In Liquid Metal Fast Breeder Reactor Materials Development Program. Quarterly progress report for period ending March 31, 1977.

Most of the transition joints of the CRBRP will consist of trimetallic joints employing a spool piece of alloy 800 H. A summary of available creep and tensile data for 800H is presented, including analytical representations. Strength properties, ductility properties, stress—strain relations, creep properties, rupture life, time to tertiary creep, creep strain to tertiary creep, and creep strain—time behavior are discussed. 35 figures, 8 tables. (RWR)

35611 (ORNL—5309, pp 223-245) **Creep and tensile properties of transition weld joint materials.** Klueh, R.L.; King, J.F. Nov 1977.

In Liquid Metal Fast Breeder Reactor Materials Development Program. Quarterly progress report for period ending March 31, 1977.

Mechanical properties of filler materials used in welded transition joints of the CRBRP intermediate heat exchanger were investigated. Tensile properties, creep and rupture behavior of Inconel 82 (ERNiCr-3) welded metal are discussed. 13 figures, 5 tables. (RWR)

35612 (ORNL—5309, pp 245-261) **Fatigue properties of transition weld joint materials.** Strizak, J.P.; Brinkman, C.R.; King, J.F. Nov 1977.

In Liquid Metal Fast Breeder Reactor Materials Development Program. Quarterly progress report for period ending March 31, 1977.

CRBRP piping weld joints will use ERNiCr-3 (commonly known as Inconel 82) as a weld filler metal (among others). Fatigue data on ERNiCr-3 are presented. Tests conducted on material in the 2¼ Cr—1 Mo steel heat-affected zone adjacent the fusion line are also discussed. Cyclic stress—strain and continuous-cycle strain-controlled fatigue properties were defined over the range 22 to 593°C. A comparison between ERNiCr-3 deposited by the automatic hot- and cold-wire gas tungsten-arc processes indicated that fatigue life of hot-wire material was slightly superior to that of the cold-wire material; however, similar cyclic stress—strain response of the two materials was found. 12 figures, 3 tables. (RWR)

35613 (ORNL—5309, pp 7-22) **Creep and rupture behavior of 2 1/4 Cr—1 Mo steel.** Klueh, C.R. Nov 1977.

In Liquid Metal Fast Breeder Reactor Materials Development Program. Quarterly progress report for period ending March 31, 1977.

Creep—rupture curves are shown for tempered bainitic steel plate and weld metal at 454, 510, and 566 C; a comparison of stress vs minimum creep rate relations is also given for the same conditions. Time and strain to onset of tertiary creep are tabulated for a 22-mm rod of normalized and tempered steel and for tempered weld metal. Data on stress to rupture in 10^4 hours are given for bainitic and proeutectoid ferrite steels. 5 figures, 4 tables. (RWR)

35614 (ORNL—5309, pp 22-35) **Mechanical properties of a 2 1/4 Cr—1 Mo steel forging for LMFBR tubesheets.** Klueh, R.L.; Griffith, J.L. Nov 1977.

In Liquid Metal Fast Breeder Reactor Materials Development Program. Quarterly progress report for period ending March 31, 1977.

Forging and heat treatments undergone by the specimen are recalled. Samples were taken at various positions and orientations. A definite change in microstructure along the radius was noted: the amount of bainite increased from 10% at the surface to 30% near the center of the cylindrical forging. Metallography revealed that two types of bainite formed. Tensile tests showed that an increasing amount of bainite led to increasing strength. Results for tensile properties are presented for various orientations, locations, and temperatures. The cooling process for the forging is discussed. It is felt that a more uniform microstructure is achievable by a normalizing treatment than by isothermal annealing. 7 figures, 4 tables. (RWR)

35615 (ORNL/NUREG/TM—171) **Assessment of lamellar tearing.** McEnerney, J.W. (Oak Ridge National Lab., Tenn. (USA)). Mar 1978. Contract W-7405-ENG-26. 59p. Dep. NTIS, PC A04/MF A01.

Information on lamellar tearing is summarized and related to proposed ASME Code requirements. Lamellar tearing is characterized as a complex phenomenon related to poor short transverse ductility and through-thickness strain. The material, welding, and design variables that affect lamellar tearing are shown to be complex and interrelated. The commonly reported tests for assessing material susceptibility are described, with the controversy over their validity being carefully detailed. Although the use of a nondestructive test such as ultrasonic examination is most desirable, a widely applicable test method does not appear to be available. Of the destructive tests, the short transverse tensile reduction-of-area currently offers the most applicable means of assessing material susceptibility. However, because of the importance of matrix toughness, the short transverse Charpy V-notch test should be considered for use as an additional test if acceptance limits are developed. The ultrasonic detection of lamellar tears is susceptible to interpretation errors, which can make it overly conservative and lead to unnecessary repairs. The repair of tears is described as costly, difficult, and sometimes ineffective. Current design requirements appear to preclude any failures during static and fatigue service loads. However, without improvement of short transverse ductility, certain dynamic service loads could cause lamellar tearing failures. Two alternate design paths are recommended to prevent tearing during fabrication or service loading. The current and proposed ASME requirements dealing with lamellar tearing are reviewed and recommendations are made.

35616 (ORNL/TM—6128) **Stress-strain behavior of ERNiCr-3 weld filler metal under strain controlled cyclic loading.** Baylor, V.B.; Booker, M.K.; Strizak, J.P.; Klueh, R.L. (Oak Ridge National Lab., Tenn. (USA)). Jan 1978. Contract W-7405-ENG-26. 39p. .

Weld filler metal ERNiCr-3 is expected to be used in the transition joints of the steam generators in breeder reactors. Design and analysis of these joints require consideration of the mechanical properties of the materials involved. This study suggests analytical representations for the cyclic stress—strain response of ERNiCr-3 as observed during strain-controlled continuous-cycling fatigue tests. Specifically, areas to be discussed include cyclic hardening and softening during testing, development of cyclic stress—strain curves from stress—strain amplitude coordinates, and development of bilinear representations of cyclic stress—strain behavior as recommended for inelastic analysis by current interim inelastic design rules. Those rules were originally developed for austenitic steels, but were extended here to provide a framework within which to analyze the behavior of ERNiCr-3. 33 figures, 4 tables.

35617 (SAND—77-1556) **Elevated temperature creep and fatigue damage of a 2.25 Cr—1 Mo steel weldment.** Van Den Avyle, J.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jan 1978. Contract EY-76-C-04-0789. 35p. Dep. NTIS, PC A03/MF A01.

In weldments between dissimilar metals wide variations occur in metallurgical structure and mechanical properties, so that for good structural design it is necessary to understand the mechanical response of individual microstructural segments of the weld. This study investigates elevated temperature properties of a 2.25 Cr—1 Mo ferritic steel base metal welded with Chromenar 382V (Inconel

82) filler metal. Creep and low-cycle fatigue tests at 866°K (1100°F) show the filler metal and heat affected zone to be much stronger than the base metal. Optical microscopy does not show significant aging effects in the short-term fatigue tests or creep tests of 1180 hour duration.

35618 Hydrogen, a useful alloy element in metal alloys. Erdmann-Jesnitzer, F. (Technical Univ., Hanover). pp 6p, Paper 6B2 of Hydrogen in metals. Vol. 10. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P10.

Hydrogen was used as alloy element in PbLi(H) and in AlNi(H) alloys with specific measurements to establish an interatomic chemical bonding in the mixed crystal structure. This leads to a remarkable elevated creep resistance. The alloy elements must have an affinity to H as given by hydrides. 7 figures.

35619 Properties of powder metallurgy steel forgings. Crowson, A.; Anderson, F.E. (Army Armament Research and Development Command, Dover, NJ). *Prog. Powder Metall.;* **33**: 47-65(1977).

The effects of processing variables on the mechanical properties of heat-treated powder metallurgy (P/M) steel forgings were determined. Prealloyed 4600 steel powder blended with graphite to yield 4640 was compacted into preforms and hot forged in a warm, closed die. Variables studied were preform density, method of lubrication, preform sintering (time, temperature and atmosphere), forging pressure (20 and 40 tsi) and temperature (1850°F, 2000°F and 2200°F), and forging ratio (0.75 and 0.95). Relationships between interconnected porosity and total porosity for the various preform densities were determined. High density compacts required higher sintering temperatures due to the restricted mobility of the reducing gases in the pores. Die wall lubrication was comparable to admixed lubrication, and it simplified powder mixing and preform sintering operations. Forgings with densities from 99 to 99.8 percent of theoretical density were attained with a forging pressure of 20 to 40 tsi and preform temperatures of 2000°F and above. At forging conditions which resulted in forgings with acceptable mechanical properties, complete die fill was accomplished at a forging ratio of 0.95, whereas incomplete die fill resulted at a forging ratio of 0.75. The response of P/M forgings to heat treatment was comparable to that for wrought materials, and the resultant tensile and yield strengths were equivalent to the strength values described for wrought 4640 steel in AMS specification 6317B. In addition, ductility and impact properties of P/M forgings with near theoretical density (99.5+ percent) were comparable to bar stock forgings.

35620 Pellini test as a brittle fracture criterion for components and for the determination of the application limits of fracture mechanics. Schulze, H.D. pp 111-122 of Angewandte Bruchmeanik. Probleme aus der Sicht der Hersteller, Betreiber und Ueberwacher. Koeln, Germany, F.R.; TUeV Rheinland (1976). (In German)

From Symposium on applied fracture mechanics; Bad Neuenahr, F.R. Germany (15 Mar 1976).

See CONF-760385—.

Linear-elastic fracture mechanics have made it possible to make the brittle behaviour of cracks in components accessible for a description. The concepts envisaging an extension to yield point mechanics as well, which would allow the behaviour of cracks with large plastic deformations at the tip of the crack to be described, are at present not perfected enough yet to be applied in practice. The Pellini concept with its semi-quantitative statements closes at present this gap.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 34607, 35645, 35671, 35767, 36190, 36339

35621 (COO—1198-1190) **Electromagnetic penetration depth in superconducting alloys containing magnetic impurities.** Thomasson, J.W. (Illinois Univ., Urbana (USA)). 1977. Contract EY-76-C-02-1198. 223p. Dep. NTIS, PC A10/MF A01.

Thesis.

Measurements of the attenuation of an axial magnetic field by cylindrical, thin, superconducting films were made by using a SQUID-based magnetometer. The sample films were between 40 and 85 A thick. They were composed of indium and of indium containing a small amount of gadolinium. Each film was made by flash-evaporating pellets and quench-condensing the film onto a substrate. The sector of the cylindrical substrate not facing the evaporator was covered by a heavy indium film. Correction terms were calculated numerically to transform the attenuation measurements for the finite-length sample into equivalent values for a hypothetical, infinitely long sample which has the sample film evaporated all the way around the substrate. The film thickness was determined from the temperature dependence of the film resistance between 77 and 140 K. The electron mean free path was determined from the normal-state resistance at low temperatures. The electromagnetic penetration depth lambda, the reduced penetration depth lambda (sigma/sub n/T/sub co/)/sup 1/2/, and the London penetration depth lambda/sub L/ were determined from the corresponding magnetic field attenuation of the infinitely long sample, the film thickness, and other parameters. The results were compared with calculations based on Shiba's theory in the Abrikosov-Gor'kov limit. The best results were obtained for the thickest sample film, which was made of pure indium. Our value of lambda (sigma/sub n/T/sub co/)/sup 1/2/ was found to be 27% larger than the theoretical value of 0.120. The results indicate that thicker samples should be investigated.

35622 (COO—1198-1193) **Electromagnetic penetration depth in superconducting alloys containing magnetic impurities.** Thomasson, J.W. (Illinois Univ., Urbana (USA)). 1977. Contract EY-76-C-02-1198. 223p. Dep. NTIS, PC A10/MF A01.

Thesis.

Measurements of the attenuation of an axial magnetic field by cylindrical, thin, superconducting films were made by using a SQUID-based magnetometer. The sample films were between 40 and 85 A thick. They were composed of indium and of indium containing a small amount of gadolinium. Each film was made by flash-evaporating pellets and quench-condensing the film onto a substrate. The sector of the cylindrical substrate not facing the evaporator was covered by a heavy indium film. Correction terms were calculated numerically to transform the attenuation measurements for the finite-length sample into equivalent values for a hypothetical, infinitely long sample which has the sample film evaporated all the way around the substrate. The film thickness was determined from the temperature dependence of the film resistance between 77 and 140 K. The electron mean free path was determined from the normal-state resistance at low temperatures. The electromagnetic penetration depth lambda, the reduced penetration depth lambda(sigma/sub n/T/sub co/)/sup 1/2/, and the London penetration depth lambda/sub L/ were determined from the corresponding magnetic field attenuation of the infinitely long sample, the film thickness, and other parameters. The results were compared with calculations based on Shiba's theory in the Abrikosov-Gor'kov limit (eta/sub o/ = 1). The best results were obtained for the thickest sample film, which was made of pure indium. The value of lambda(sigma/sub n/T/sub co/)/sup 1/2/ was found to be 27% larger than the theoretical value of 0.120. The results indicate that thicker samples should be investigated.

35623 (IS-M—127) **Neutron diffraction measurements of the spatial extent of the Ce moment in the Kondo system Y:Ce.** Edelstein, A.S.; Stassis, C.; Kline, G.; Beaudry, B.; Maglic, R. (Illinois Univ., Chicago (USA); Ames Lab., Iowa (USA); Argonne National Lab., Ill. (USA)). 1977. Contract W-7405-ENG-82. 3p. (CONF-771127—14). NTIS, MF A01.

From 23. conference on magnetism and magnetic materials; Minneapolis, MN, USA (8 Nov 1977).

Portions of document are illegible.

Neutron diffraction measurements made down to 2.2°K on single crystal samples of the Kondo system Y : Ce have determined that the spatial extent of the impurity magnetic moment is the same as that of the Ce^{3+} ion. The Kondo temperature T/sub K/ is probably greater than 6°K. The magnitude of the moment determined by neutron measurements, agrees with that obtained from magnetization measurements in the temperature range 2.2 to 30°K.

35624 (ORO—3291-22) **Application of adiabatic calorimetry to metal systems. Final report.** Stansbury, E.E.; Brooks, C.R. (Tennessee Univ., Knoxville (USA). Dept. of Chemical, Metallurgical and Polymer Engineering). 1976. Contract EY-76-S-05-3291. 13p. Dep. NTIS, PC A02/MF A01.

Research on the application of adiabatic calorimetry to metal systems is described. Investigations into formation of pearlite in steels, ferromagnetic effects, cold working and annealing, solid solution alloys, pure solid metals, and pure liquid metals, are briefly described. (GHT)

35625 (UCID—17696) **Equation of state of vanadium.** Wong, L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 Jan 1978. Contract W-7405-ENG-48. 12p. Dep. NTIS, PC A02/MF A01.

A new, wide-range equation of state (EOS) for vanadium is presented. The generation of this EOS was of a fast-response nature. That is, the data base was constructed very rapidly, the analysis was very cursory, and it was inserted into the Bi-linear Logorithm (BLL) EOS library in 3 to 5 days. The composite theoretical model incorporates condensed matter, ionization equilibrium, and multiphase physics. The theoretical EOS was compared with all available high-temperature and high-pressure data for vanadium; good agreement was obtained. The welting on the Hugoniot could be observed because the Kopyshev gamma nuclear correction was used to generate the high-density region. 8 figures, 1 table.

35626 Unusual superconducting behavior of the molybdenum-technetium system. Giorgi, A.L.; Matthias, B.T. (University of California, Los Alamos Scientific Los Alamos, New Mexico 87545). *Phys. Rev., B;* **17**: No. 5, 2160-2162(1 Mar 1978).

The variation of T/sub c/ with composition was investigated for the Mo-Tc system using a quick-quench technique. A transformation of tte disordered A-15 structure to a bcc structure of the same composition with any change in T/sub c/ was observed. This investigation shows that the T/sub c/ for a completely disordered A-15 lattice is almost identical to the T/sub c/ for the bcc or hcp solid solution with the same composition.

35627 Ferromagnetic and spin-glass ordering in Fe-doped Au/sub x/Pd/sub 1-x/ alloys. Domb, E.R.; Sellmyer, D.J.; Quick, T.M.; Borg, R.J. (Behlen Laboratory of Physics, University of Nebraska, Lincoln, Nebraska 68588). *Phys. Rev., B;* **17**: No. 5, 2233-2244(1 Mar 1978).

Ferromagnetic and spin-glass ordering has been studied in (Au/sub x/Pd/sub 1-x/)/sub 1-c/Fe/sub c/ alloys for $0 < \text{or} = x < \text{or} = 1$ and $0 < \text{or} = c\ 9$ or $\simeq 0.06$. Magnetic susceptibility, high-field magnetization, and Moessbauer measurements have been performed between liquid-helium and room temperature. For small x, the alloys are strongly exchange enhanced. Assuming that the local-moment—conduction-electron exchange coupling J is independent of x, and employing the Takahashi-Shimizu-Doniach-Wohlfarth theory, we obtain $J = 0.12$ eV from the saturation moment vs host susceptibility data. The theory, however, fails to describe the inter-impurity coupling that leads to magnetic order in the Pd-rich alloys. A simple phenomenological model, based on the ferromagnetic coupling of all the giant polarization clouds except those that are "isolated," gives qualitative agreement with the T/sub C/(c) data, where T/sub C/ is the ordering temperature. The magnetic ordering changes from ferromagnetic to spin glass or mictomagnetic as x increases beyond about 0.5. This seems to be connected with the change at this composition in the character of the electronic states at the Fermi level from d-like to s-like. The Au-rich samples are spin glasses understandable in terms of the Sherrington-Southern theory which is based on fluctuations in the exchange couplings of the Fe spins. The magnitude of this coupling was estimated in two ways, employing the theories of Sherrington-Southern and Larkin, and the results were in reasonable agreement with each other.

35628 Magnetic susceptibility of $AnRe_2$ compounds. Brodsky, M.B.; Trainor, R.J.; Aldred, A.T.; Sowers, C.H. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439). *J. Appl. Phys.;* **49**: No. 3, 1498-1499(Mar 1978).

The compounds $AnRe_2$, where An=Th, U, Np, and Pu all have the $MgZn_2$-type hexagonal Laves phase structure. Measurements of their magnetic susceptibilities have been made from 2 to 300 K. Whereas $ThRe_2$, URe_2, and $PuRe_2$ have essentially temperature-independent susceptibilities, $NpRe_2$ is ferromagnetic with T/sub c/=47 K. The paramagnetic data for $NpRe_2$ follow a modified Curie-Weiss law, chi-chi$_0$=C/(T-θ) from 60 to 230 K with θ=47.4 K and C equivalent to an effective moment, p/sub eff/=2.11μ/sub B/. The ordered moment μ_0=0.90μ/sub B/ and the results are consistent with other actinide compounds having good local moment behavior. The electronic specific heat γ of URe_2=34 mJ/(mole K^2) is large enough to indicate the possibility of spin-fluctuation behavior in this compound.

35629 Neutron diffraction measurements of the spatial extent of the Ce moment in the Kondo system Y : Ce. Edelstein, A.S.; Stassis, C.; Kline, G.; Beaudry, B.; Maglic, R. (University of Illinois at Chicago Circle, Chicago, Illinois 60680). *J. Appl. Phys.;* **49**: No. 3, 1503-1505(Mar 1978).

Neutron diffraction measurements made down to 2.2 K on single crystal samples of the Kondo system Y:Ce have determined that the spatial extent of the impurity magnetic moment is the same as that of the Ce^{3+} ion. The Kondo temperature T/sub K/ is probably greater than 6 K. The magnitude of the moment determined by neutron measurements agrees with that obtained from magnetization measurements in the temperature range 2.2 to 30 K.

35630 Susceptibility measurements on the valence fluctuation system (Yb,Sc)Al_3. Majewski, R.E.; Edelstein, A.S.; Aldred, A.T.; Dwight, A.E. (University of Illinois at Chicago Circle, Chicago, Illinois 60680). *J. Appl. Phys.;* **49**: No. 3, 2096-2097(Mar 1978).

The susceptibility of Yb/sub x/Sc/sub 1-x/Al_3 (Cu_3Au-type structure) for x=0.1, 0.2, 0.5 and 1.0 has been measured from 4.2 to 700 K. In contrast to Ce-Th alloys, the addition of a smaller atom, Sc, to $YbAl_3$ favors the configuration with a larger atomic volume, Yb^{2+}. The susceptibility per mole Yb exhibits a broad maximum which shifts to lower temperatures with increasing x. Room temperature lattice constant measurements indicate that the valance increases gradually from ~2.7 at x=0.1 to ~2.9 at x=1.0. Fitting our data to the resonant level-type model of Sales, we find that the width of the resonant level X decreases dramatically with increasing x. All the data approximately satisfies a scaling relationship.

35631 Spin waves in ferromagnetic Tb/sub 0.76/Y/sub 0.24/. Wakabayashi, N.; Nicklow, R.M.; Child, H.R. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Appl. Phys.;* **49**: No. 3, 2131-2132(Mar 1978).

The conduction electron susceptibility chi (q) is considered to play an important role in the magnetism of rare-earth metals and alloys. In order to obtain information about chi (q), studies of the spin waves in the alloy Tb/sub 0.76/Y/sub 0.24/ have been carried out in a magnetic field. The magnetic structure of this alloy was found to remain spiral down to liquid helium temperature with zero field. The spin-wave dispersion curve in this structure has already been studied along the c*-direction, and the results were analyzed successfully in terms of a susceptibility function corresponding to a one-dimensional system with a slight modification. In order to obtain somewhat independent information about chi (q), the spin-wave dispersion curve for the ferromagnetic phase has been studied. A field of 14 kG was necessary to transform the structure into a ferromagnet at liquid helium temperature. Spin-wave energies which are calculated in terms of the susceptibility function determined from the measurements in the spiral structure agree rather well with the observed energies. A large damping and softening of the spin wave has been observed near the wave vector q=0.16 which characterized the spiral configuration. The origin of the phenomenon may be related to the instability of the ferromagnetic structure.

35632 Calculation of the electronic transition in cesium. McMahan, A.K. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). *Phys. Rev., B;* **17**: No. 4, 1521-1527(15 Feb 1978).

The behavior of cesium under compression is unusual not only because of the isostructural transition at 4.25 GPa, but also because of the abnormal softness of the isotherm at lower pressures. Self-consistent augmented-plane-wave Xα calculations of the T = 0, fcc cesium pressure-volume isotherm are reported which suggest that both phenomena may be due to the electronic s-d transition in this material. It is demonstrated that in the vicinity of an electronic transition, such techniques are very poorly convergent with the number of points taken in the Brillouin zone, and that great care must be exercised to insure that the results are physically meaningful.

35633 Electron-spin polarization in low-energy electron diffraction from tungsten (001). Kalisvaart, M.; O'Neill, M.R.; Riddle, T.W.; Dunning, F.B.; Walters, G.K. (Department of Physics, Rice University, Houston, Texas 77001). *Phys. Rev., B;* **17**: No. 4, 1570-1578(15 Feb 1978).

Combined measurements in low-energy electron diffraction of both electron-spin polarization and intensity are described for beams from W(001). Polarization and intensity are determined in the energy range 20-150 eV for both the 10 and 11 beams at normal incidence and for the 00 beams at angles of incidence from 10° through 18° in 1° steps. Electron-spin polarizations in the range +60--80% are observed with polarization values highly dependent on both the energy and the angle of incidence of the primary electron beam. For the 00 beam at 11° angle of incidence and for the 10 beam at normal incidence, comparisons of the present intensity and polarization data with the results of recent theoretical calculations are encouraging with respect to gross features.

35634 Heat of solution of hydrogen in Al and Mg. Jena, P.; Singwi, K.S. (Department of Physics and Astronomy and Materials Research Center, Northwestern University, Evanston, Illinois 60201). *Phys. Rev., B;* **17**: No. 4, 1592-1595(15 Feb 1978).

Electron charge distibution around a proton in Al and Mg has been calculated self-consistently using the Kohn-Sham density functional formalism. The exchange-correlation potential has been treated both in the local-density approximation and including the first gradient correction. The results are used to compute the heat of solution of hydrogen in Al and Mg. Comparison has been made with earlier theoretical and experimental values.

35635 Oscillatory magnetotransport in $NbSe_3$ and $TaSe_3$. Fleming, R.M.; Polo, J.A. Jr.; Coleman, R.V. (Department of Physics, University of Virginia, Charlottesville, Virginia 22901). *Phys. Rev., B;* **17**: No. 4, 1634-1644(15 Feb 1978).

Shubnikov-de Haas oscillations in $NbSe_3$ and $TaSe_3$ have been observed in the field range 0-170 kG using both ac and dc techniques. The Fermi-surface sections have been tracked over a substantial angular range and the observed anisotropies are consistent with elongated ellipsoids. In $NbSe_3$ a single section with a minimum frequency of 0.28 MG dominates the oscillatory behavior and develops a strong harmonic content at high fields. Fits of the data to expressions including the spin splitting of the Landau levels gives a minimum g factor of 3.2 and a Dingle temperature of T/sub D/ = 2.3 K. The temperature dependence of the amplitude gives an effective mass of 0.24 for this section. The Hall effect has also been measured in $NbSe_3$ and shows a sign change from positive to negative as the temperature is decreased below the 59-K transition in $NbSe_3$. No significant change is observed near the 145-K transition. In $TaSe_3$ at least 20 frequencies in the range 0.7-22 MG have been

observed and these exhibit a distribution of fairly strong amplitudes with no single frequency dominating. The crystals of $NbSe_3$ and $TaSe_3$ are of comparable quality and resistance ratio so the results indicate that the Fermi surfaces have quite different parameters in the two metals.

35636 ^{93}Nb Knight shift and quadrupole coupling parameters in the orthorhombic β phase hydride and deuteride of niobium. Hwang, Y.S.; Torgeson, D.R.; Barnes, R.G. (Ames Lab., Iowa (USA)). *Solid State Commun.;* **24**: No. 11, 773-775(Dec 1977).

The Knight shift tensor components and quadrupole coupling parameters of the ^{93}Nb NMR have been measured for the first time in the orthorhombic β phase hydride and deuteride of niobium. The isotropic component of the Knight shift tensor has the same value in the hydride phase as in the solid solution (α) phase at the same composition, indicating that no significant change in band structure details occurs as a consequence of the structural phase transition. Comparison of the measured asymmetry parameter of the quadrupole interaction with calculated values indicates that the probable Nb environment is that of the ordered NbH structure. Estimates of the activation energy for hydrogen (deuterium) diffusion are obtained from the temperature dependence of the linewidths of spectrum features.

35637 Magnetic hysteresis of the hyperfine field at impurity tin in metallic holmium. Bogdanov, P.V.; Godovikov, S.K.; Kozin, M.G.; Shpinel', V.S. (Nuclear Physics Institute of the Moscow State University). *JETP Lett. (USSR) (Engl. Transl.);* **26**: No. 4, 214-217(20 Aug 1977).

Cancellation of the internal and hyperfine fields at the Sn^{119} nuclei in Ho has been observed following application of an external magnetic field, and hysteresis of the hyperfine interaction was observed after the field was removed. A connection is established between these phenomena and the realignment and "freezing" of the magnetic structure.

35638 Absorption and adsorption of electrochemically generated hydrogen by gold electrodes. Choa, F.; Costa, M. (Centre National de la Recherche Scientifique, Meudon, France). pp 7p, Paper 5A8 of Hydrogen in metals. Vol. 9. Elmsford, NY; Pergamon Press Inc. (1977). (In French)

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P9.

Atomic hydrogen, cathodically generated in N-H_2SO_4 solutions, can diffuse into solid conventional gold electrodes and through gold membranes. Diffusion coefficient of hydrogen through gold membranes at room temperature was calculated (5×10^{-12} cm^2s^{-1}). Two sorts of interaction of anodically oxidizable hydrogen with gold were found. 8 figures, 2 tables.

35639 Role of the metallic substrate in acidic medium on the blocking of oxygen reduction by hydrogenated species coverage. Caprani, A.; Morel, P. (Centre National de la Recherche Scientifique, Paris). pp 9p, Paper 5A10 of Hydrogen in metals. Vol. 9. Elmsford, NY; Pergamon Press Inc. (1977). (In French)

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P9.

The influence of dissolved oxygen on the equilibrium between two adsorbed hydrogen species differing by their life time was studied by use of a rotating disk electrode. The studied metals (Fe,Ti,Ni,Al) were classified from criteria taking into account the life-time of the higher bonded species H*/sub ads/, the blocking ratio, and the energy of the Me - H*/sub ads/ bond. 6 figures.

35640 Investigation of cathodic hydrogen absorption by titanium and cathodic attack of titanium. Tomashov, N.D.; Modestova, V.N.; Vlasova, E.S.; Zakharov, A.I.; Gorodetski, A.E.; Balashova, N.N. (Inst. of Physical Chemistry, Moscow). pp 8p, Paper 5A11 of Hydrogen in metals. Vol. 9. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P9.

The influence of surface preparation and solution composition on titanium hydrogen absorption decreases with longer experiment times and greater current densities. Titanium attack in 0.5 NaCl solution occurs through peeling off of hydride plates due to internal compression stresses. 4 figures.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 34342, 34387, 34479, 34643, 34980, 34981, 35005, 35036, 35569, 35579, 35603, 35604, 35608, 35742, 36550

35641 (ORNL—5309, pp 1-7) **Steam-side/water-side corrosion: the effect of heat flux on the corrosion of 2 1/4 Cr—1 Mo steel by superheated steam.** Griess, J.C.; DeVan, J.H.; Maxwell, W.A. Nov 1977.

In Liquid Metal Fast Breeder Reactor Materials Development Program. Quarterly progress report for period ending March 31, 1977.

Tests on vacuum-arc-remelted (VAR) steel are reported and compared with previous results from air-melted material. Specimen surface temperature ranged from 502 to 522°C. Data on weight change and penetration are presented. Effects of heat flux on penetration are noted. 3 figures, 2 tables. (RWR)

35642 (ORNL—5309, pp 36-38) **Thermal aging effects on 2 1/4 Cr—1 Mo steel.** Klueh, R.L.; Griffith, J.L. Nov 1977.

In Liquid Metal Fast Breeder Reactor Materials Development Program. Quarterly progress report for period ending March 31, 1977.

Room-temperature and aging-temperature tensile properties are tabulated for aged commercial tubing heats of 2¼ Cr—1 Mo steel. Aging time runs to 10,000 hours. Temperatures are 850, 950, and 1050 F. 2 tables. (RWR)

35643 (ORNL—5309, pp 36, 39-43) **Effect of sodium on the mechanical properties of 2 1/4 Cr—1 Mo steel.** Klueh, R.L. Nov 1977.

In Liquid Metal Fast Breeder Reactor Materials Development Program. Quarterly progress report for period ending March 31, 1977.

Creep rupture tests were conducted on specimens that had been exposed to sodium for 26,500 hours at 1050°F; specimens aged in a helium atmosphere under similar conditions were also tested. Elongation as a function of rupture life went through a maximum for both the aged specimen and the one decarburized by sodium. The maximum was higher for the helium-aged material, but results appear similar for longer rupture life. All fractures were ductile transgranular fractures. 4 figures, 1 table. (RWR)

35644 Effect of cathodic hydrogen on the corrosion of stainless steels AISI-420 and AISI-316 in sulfuric solutions containing AS_2O_3. Quaranta Cabral, U.; Rodrigues, V.L.R.K. pp 7p, Paper 5A4 of Hydrogen in metals. Vol. 9. Elmsford, NY; Pergamon Press Inc. (1977). (In French)

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P9.

The influence of the As_2O_3 content on the cathodic polarization curves and weight loss measurements of two stainless steels in 1N H_2SO_4 solutions was studied. A general inhibiting action is observed for both steels, but a corrosion maximum happens to AISI-420 steel in solutions containing 1 and 2 mg/l of As_2O_3. Results are discussed. 13 figures, 4 tables.

35645 Hydrogen penetration and embrittlement of high strength steel during electroplating. Paatsch, W. (Bundesanstalt fuer Materialprufung, Berlin). pp 4p, Paper 5A5 of Hydrogen in metals. Vol. 9. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P9.

Hydrogen uptake of steel and the penetration behavior during electroplating conditions were studied by use of the electrochemical permeation method. Constant load rupture tsts were carried out to find the relationship between electroplating conditions and hydrogen embrittlement of high-tensile-strength steel. 3 figures.

35646 Study of steel hydrogen absorption during electrodeposition of titanium alloyed zinc. Kudriavtsev, V.N.; Liahov, B.F.; Anuphriev, N.G.; Pedan, K.S. (Inst. of Physical Chemistry, Moscow). pp 6p, Paper 5A7 of Hydrogen in metals. Vol. 9. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P9.

High-strength steel hydrogen absorption during zinc cyanide plating is eliminated by way of alloying of coatings with titanium. The side processes of intermetallic compound formation and decomposition which may be responsible for steel hydrogen absorption are possible during electrodeposition of metals. 3 tables.

35647 Microstructural study of hydrogen cracking in mild steel. Akhurst, K.N.; Pumphrey, P.H. (General Electricity Research Labs., Leatherhead, Eng.). pp 8p, Paper 3B1 of Hydrogen in metals. Vol. 9. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P9.

A microstructural study of mild steel after cathodic charging shows that hydrogen-induced cracks nucleate preferentially near the free surface and are associated with Fe_3C particles. A model for crack growth is presented. 9 figures.

35648 Effect of microstructure on the hydrogen embrittlement of a 0.8% carbon steel. Ryder, D.A.; Davies, T.J.; Strecker, E. (Univ., Manchester, Eng.). pp 10p, Paper 3B2 of Hydrogen in metals. Vol. 9. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P9.

The susceptibility to hydrogen embrittlement of a 0.8% carbon steel in two microstructural conditions, patented and cold worked, or hardened and tempered and of almost identical tensile strength was examined. The cold-worked pearlitic material is much more resistant to embrittlement than the martensitic material. 10 figures, 4 tables.

35649 Influence of microstructure on hydrogen embrittlement in high strength steel. Wood, W.E.; Das, K.B.; Parrish, P.A. (Oregon Graduate Center, Beaverton). pp 7p, Paper 3B3 of Hydrogen in metals. Vol. 9. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P9.

The influence of retained austenite on the threshold stress intensity level of ultrahigh-strength martensitic steel is evaluated. Increased resistance to hydrogen-induced cracking is observed by introducing retained austenite into the structure. 2 figures, 3 tables.

35650 Contribution to study of effect of hydrogen on fracture characteristics of martensitic steels. Pahuta, P.; Karel, V.; Hyspeck, L.; Mazanec, K. pp 7p, Paper 3B6 of Hydrogen in metals. Vol. 9. Elmsford, NY; Pergamon Press Inc. (1977). (In French)

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P9.

Independent from the presence or absence of hydrogen in the martensite of the FeNiC alloys there were four modes of fracture. The hydrogen caused only a change in the proportion of these modes of fracture. 5 figures, 1 table.

35651 Initiation of hydrogen-induced cracking at stressed notches in steels. McIntyre, P.; Walker, E.F. (British Steel Corp., Rotherham). pp 10p, Paper 3B8 of Hydrogen in metals. Vol. 9. Elmsford, NY; Pergamon Press Inc. (1977).

A study was made of the factors which influence the susceptibility of steels to hydrogen-induced cracking at notched surfaces. For maximum resistance to cracking the steels should be ferritic, have a yield strength below 1100 N/mm^2, and be free from hard surface layers. 6 figures, 6 tables.

35652 Hydrogen embrittlement of coal gasifier steels. Morris, J.G.; Roopchand, B.J. (Univ. of Kentucky, Lexington). pp 11p, Paper 3B9 of Hydrogen in metals. Vol. 9. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P9.

All multiphased ferrous alloys are embrittled by hydrogen with the embrittling tendency being less for a pearlitic structure than for a bainitic or martensitic structure. Even predominately one phase ferrous materials are embrittled by hydrogen if the second phase particles that are present are non-spheroidal in morphological form. Unique thermomechanical processing operations have been devised to produce microstructures in ferrous alloys that minimize the tendency for hydrogen embrittlement.

35653 Hydrogen in metals. Volume 10. Elmsford, NY; Pergamon Press Inc. (1977). 116p. (In English and French). (CONF-770613—P10).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

A separate abstract was prepared for each of the 15 papers in this volume. (RWR)

35654 Hydrogen induced delayed crack formation at submerged-arc welding of fine grain steel. Erdmann-Jesnitzer, F.; Rehfeldt, D. (Technical Univ., Hanover). pp 8p, Paper 6B3 of Hydrogen in metals. Vol. 10. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P10.

Hydrogen-induced delayed cracks depend on the flux—wire combination. Crack formation is due to a catalytic reaction, influenced by dislocations. Stepwise crack propagation depends on a Gorski—Cottrell effect. Structure and inhomogeneous H distribution determine sensitivity to cracks. 11 figures.

35655 High temperature oxidation of formed aluminum parts. Levy, S.A.; Mapes, R.S. (Reynolds Metals Co., Richmond, VA). pp 7p, 6B4 of Hydrogen in metals. Vol. 10. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P10.

While attempting to produce deep drawn cups of alloy 7475, rather severe high temperature oxidation (HTO) was found, at times. An attempt was made to optimize processing, for high toughness, and still avoid HTO. 1 table.

35656 Influence of cyclic plastic strain on the rate of hydrogen reduction at metal surfaces. Patel, C.; Rollins, V.; Pyle, T. (Lanchester Polytech., Coventry, Eng.). pp 8p, 6B6 of Hydrogen in metals. Vol. 10. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P10.

A significant enhancement of hydrogen reduction rate occurs during cyclic plastic straining of cathodically polarized mild steel in 3.5% NaCl solutions. The magnitude of the observed effects depends on the strain magnitude, the sign of the strain reversal, and the extent of cathodic polarization. 7 figures, 2 tables.

35657 Study of the hydrogen effects on the plastic flow of iron by electron microscopy and tensile tests. Cornet, M.; Rzepski, J.; Talbot-Besnard, S. (CECM—CNRS, Vitry-sur-Seine, France). pp 7p, Paper 3A1 of Hydrogen in metals. Vol. 10. Elmsford, NY; Pergamon Press Inc. (1977). (In French)

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P10.

In pure iron single crystals and polycrystals, hydrogen—dislocation interaction alters the dislocation pattern and modifies the deformation process. In connection with a likely hydrogen—vacancy interaction, it also gives rise to the formation of numerous dislocation loops. 3 figures.

35658 Influence of orientation on the plasticity of hydrogen charged iron single crystals. Matsuyama, S.; Plusquellec, J.; Azou, P.; Bastien, P. (Ecole Centrale des Arts et Manufactures, Chatenay-Malabry, France). pp 8p, Paper 3A2 of Hydrogen in metals. Vol. 10. Elmsford, NY; Pergamon Press Inc. (1977). (In French)

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P10.

The effects of hydrogen on the flow properties of iron depends on the operative slip system: (anti 101)[111] or (anti 211)[111]. The proposed hypothesis to explain these results seems to be applicable for the mechanism of hydrogen embrittlement. 9 figures.

35659 Hydrogen transport on plastic deformation and fracture of steels in tension. Kikuta, Y.; Araki, T.; Oschiai, S. (Osaka Univ., Suita, Japan). pp 8p, Paper 3A3 of Hydrogen in metals. Vol. 10. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P10.

The effect of deformation on hydrogen diffusion was studied by an electrochemical flux monitoring technique during tensile test and constant load rupture test. These tests were carried out over a range of aging time and strain rates, on notched specimens of steel, hydrogen charged and quenched. 14 figures, 1 table.

35660 Fracture morphology of hydrogen induced cracking and weld cold cracking in steel. Kikuta, Y.; Araki, T.; Kuroda, T. (Osaka Univ., Suita, Japan). pp 8p, Paper 3A4 of Hydrogen in metals. Vol. 10. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P10.

The relationship between fracture morphology of hydrogen embrittlement and microstructure, and the crystallographic orientation of the morphology were investigated by means of electron fractography. The three points bending test and the implant weld cracking test were carried out. 9 figures, 1 table.

35661 Hydrogen embrittlement of a boron steel. Tobe, Y.; Tyson, W.R. (CANMET, Ottawa). pp 9p, Paper 3A5 of Hydrogen in metals. Vol. 10. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P10.

The effects of internal hydrogen on tensile ductility of a commercial HSLA, Q and T steel were investigated. The results are consistent with a decohesion mechanism assisted by hydrogen pressure in voids, limited by hydrogen transport at low temperatures. 8 figures, 1 table.

35662 Influence of hydrogen on plastic fracture processes. Thompson, A.W.; Bernstein, I.M. (Carnegie—Mellon Univ., Pitts-

burgh). pp 8p, Paper 3A6 of Hydrogen in metals. Vol. 10. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P10.

Understanding of hydrogen-assisted fracture requires understanding both of microstructural origins of fracture and of hydrogen interactions with those origins. 3 figures.

35663 Cathodic hydrogenation of iron and steel at high temperature in molten salt bath. Apparition of new conditions of fragilization by hydrogen. Elkholy, A.; Galland, J.; Plusquellec, J.; Azou, P. (Ecole Centrale des Arts et Manufactures, Chatenay Malabry, France). pp 8p, Paper 3A7 of Hydrogen in metals. Vol. 10. Elmsford, NY; Pergamon Press Inc. (1977). (In French)

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P10.

At both room and low temperature, new conditions for absorption and embrittlement of hydrogen introduced in iron and steels were observed by cathodic hydridation in mixed molten salt baths mainly by intergranular decohesion. The embrittlement reversibility in those conditions was studied, too. 7 figures.

35664 Influence of hydrogen introduced by welding on the steels behavior in thickness direction. Nicolescu, A.; Tudosie, M. pp 8p, Paper 3A8 of Hydrogen in metals. Vol. 10. Elmsford, NY; Pergamon Press Inc. (1977). (In French)

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P10.

The implant cracking test was used to determine the analogy between "lamellar tearing" in the welding HAZ and the delayed fracture; the same influence of hydrogen level was obtained. Through this analogy practical methods to avoid the phenomenon are proposed. 4 figures.

35665 Hydrogen pick up by titanium held cathodic in sea water. Sato, H.; Fukuzuka, T.; Shimogori, K.; Tanabe, H. (Kobe Steel, Ltd., Japan). pp 8p, Paper 6A1 of Hydrogen in metals. Volume 3. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P3.

Hydrogen pick up by titanium tubes coupled with copper alloy tube plate held cathodic in flowing sea water was studied by using a model condenser. For preventing hydrogen absorption, potential should be more noble than -0.75 V, and oxidation treatment was effective. 7 figures, 1 table.

35666 Structural steels versus problems raised by their use in the presence of hydrogen. Zmudzinski, C.; Bretin, L.; Toitot, M. (Creusot-Loire, LeCreusat, France). pp 8p, Paper 6A2 of Hydrogen in metals. Volume 3. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P3.

At present, there exists some difficulty in establishing exact rules for industry builders' choice of steels for use in the presence of hydrogen in well-defined (pressure and temperature) conditions. Experience is related which allows some guidelines concerning the choice among some grades of steels to be set up. 5 figures.

35667 Hydrogen embrittlement of pressure vessel steels. Hyspecka, L. (Vitkovice, Ostrava, Czech.); Tvrdy, M.; Mazanec, K. pp 8p, Paper 6A3 of Hydrogen in metals. Volume 3. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P3.

The highest K/sub ISH/ value was ascertained in the steel 15Cr3Mo with the highest tempered bainitic structure. The lowest K/sub ISH/ value was found in the steel with ferritic-pearlitic structure.

35668 Cracking due to hydrogen in weldments of a pressure vessel for hydrogen service. Ohnishi, K.; Watanabe, J.; Chiba, R.; Murai, M. (Japan Steel Works, Ltd., Muroran). pp 8p, Paper 6A4 of Hydrogen in metals. Volume 3. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P3.

Cracks found in 347 internal attachment welds of a reactor for a high-temperature, high-pressure hydrogen service were studied. One of the possible causes of cracking is low cycle fatigue cracking induced by repetition of thermal stress to embrittled weld metal. 347 weld metal loses its ductility by presence of sigma phase and hydrogen.

35669 Hydrogen embrittlement of cadmium plated high strength structural steels. Kunze, E. (Techn. Ueberwachungs-Verein Rheinland E.V., Cologne). pp 8p, Paper 6A5 of Hydrogen in metals. Volume 3. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P3.

The effect of different cadmium plating solutions on the hydrogen embrittlement (HE) of high-strength steel was investigated. HE decreases in the order: brightening cyanide, fluoroborate, non-brightening cyanide, sulfamate, ammonium chloride. In the later three electrolytes HE reaches a value demanded by the jet aircraft industry. 6 figures.

35670 Hydrogen in metals. Volume 9. Elmsford, NY; Pergamon Press Inc. (1977). 114p. (In English and French). (CONF-770613—P9).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

A separate abstract was prepared for each of the 15 papers in this volume. (RWR)

35671 Theoretical considerations and electrochemical investigations on H-adsorption, H-diffusion, and H-induced SCC of low-alloyed steels. Poepperling, R.; Schwenk, W. (Mannesmann-Forschungsinstitut, Duisburg, Ger.). pp 5p, Paper 5A1 of Hydrogen in metals. Vol. 9. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P9.

Information on H adsorption cannot be derived by polarization experiments. Permeation and absorption data gave no relation to the SCC behavior of different steel grades, but did give applicable information on H absorption in different environments.

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 35016, 35047, 36576

35672 (HEDL-SA—1253) Summary report on the Alloy Development Intercorrelation Program experiment. Garner, F.A.; Powell, R.W.; Keefer, D.W. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Mar 1977. Contract EY-76-C-14-2170. 30p. (CONF-770639—2). NTIS, MF A01.

From Workshop on correlation of neutron and charged particle damage; Oak Ridge, TN, USA (8 Jun 1977).

Portions of document are illegible.

The Alloy Development Intercorrelation Program is a national intercorrelation program designed to refine charged-particle irradiation techniques employed in the simulation of neutron-induced swelling of metals. Using a simple well characterized Fe-15Cr-25Ni alloy with a low level of impurities, comparative irradiations were performed using 1.0 MeV electrons, 0.75 MeV protons and nickel ions at three incident energies, 2.8, 3.5 and 5.0 MeV. Fast reactor neutron irradiation is also proceeding on this material. The observed differences in swelling behavior are not closely related to the identity or energy of the bombarding species, although light charged particles are considerably more effective in the creation of voidage per displaced atom. The incubation period preceding the onset of steady-state swelling was found to be quite sensitive to experimental variables related to the softness of the metal and the proximity and method of preparation of the specimen surface. The presence or absence of displacement cascades had no measurable influence on the nucleation of voids. There appears to be an intrinsic swelling rate for this alloy which is dependent only on temperature and displacement flux, and which is independent of the duration of the incubation period. The displacement dose and dose rates calculated by standard procedures cannot be used to correlate the magnitude of the swelling caused by various charged particles. An effective dose concept is defined, with experimental measurements providing good estimates of dose equivalences for electrons, nickel ions and eventually for neutrons. The displacement effectiveness for proton irradiations is larger than anticipated, with the experiment yielding only an approximate dose equivalency factor.

35673 Critical experiments measuring the reactivity worths of materials commonly encountered as fixed neutron absorbers. Bierman, S.R.; Durst, B.M.; Clayton, E.D. (Battelle Pacific Northwest Labs., Richland, WA). *Nucl. Sci. Eng.;* **65**: No. 1, 41-48(Jan 1978).

There is a continuing interest in the use of fixed neutron absorbers (poisons) for criticality control, since their use would permit safely handling larger quantities of nuclear materials with reduced probability of criticality. The effectiveness of such absorbers as neutron poisons depends on self-shielding effects, which in turn are determined by the magnitude of the absorption cross sections and their variation with energy, the thickness of material, and the neutron energy spectrum. Criticality experiments were performed to obtain data on the reactivity worths of several thicknesses of the

following materials in two different neutron energy spectra: boral, cadmium, type 304-L stainless steel containing 1.6 wt% boron, type 304-L stainless steel containing 1.1 wt% boron, type 304-L stainless steel;uranium depleted to 0.2 wt% ^{235}U, lead. The measurement data reported are limited to a single region of a given absorber material in each critical assembly. Combinations of absorber materials or multiregions were not investigated; however, material thicknesses were varied from 0 to approximately 60 mm. The data are presented as sets of clean, well-defined, poisoned critical assemblies that can be used to check calculational techniqus and cross-section data in two different neutron energy spectra. The materials are listed abovee in the order of their measured relative worth as fixed poisons in either neutron energy spectrum.

35674 Radiation damage in metals. Peterson, N.L.; Harkness, S.D. (eds.). Metals Park, OH; American Society for Metals (1976). 410p. (CONF-751164—).

From Conference on radiation damage in metals; Cincinnati, OH, USA (9 Nov 1975).

Effects of point defect migration on the dimensional stability, mechanical strength, and superconducting properties of materials are covered. Five of the individual papers were prepared for the data base. (GHT)

35675 Theory of radiation induced defect production. Robinson, M.T. (Oak Ridge National Lab., TN). pp 1-27 of Radiation damage in metals. Peterson, N.L.; Harkness, S.D. (eds.). Metals Park, OH; American Society for Metals (1976).

From Conference on radiation damage in metals; Cincinnati, OH, USA (9 Nov 1975).

See CONF-751164—.

The production of point defects in irradiated metals is described briefly. The concepts introduced including: primary recoil energy spectra; radiation induced defect production; and the displacement cascade; are explained in detail. Some comparisons are made between the theoretical model and the results of low temperature low dose irradiation experiments. (GHT)

35676 Defect annealing processes in metals. Young, F.W. Jr. (Oak Ridge National Lab., TN). pp 95-124 of Radiation damage in metals. Peterson, N.L.; Harkness, S.D. (eds.). Metals Park, OH; American Society for Metals (1976).

From Conference on radiation damage in metals; Cincinnati, OH, USA (9 Nov 1975).

See CONF-751164—.

A review is presented of research in the annealing of radiation induced defects in metals. Stages in the annealing process are discussed. (GHT)

35677 Simulation experiments with the high voltage electron microscope. Laider, J.J.; Garner, F.A.; Thomas, L.E. (Hanford Engineering Development Lab., Richland, WA). pp 194-226 of Radiation damage in metals. Peterson, N.L.; Harkness, S.D. (eds.). Metals Park, OH; American Society for Metals (1976).

From Conference on radiation damage in metals; Cincinnati, OH, USA (9 Nov 1975).

See CONF-751164—.

Experimental procedures employed to minimize the effects of differences between neutron radiation effects and high energy electron effects are described. Once a basin is established by which the results of the HVEM simulation method may be evaluated, it is shown how the method has been applied in attempts to expand the understanding of irradiation effects related to the metal swelling phenomenon. (GHT)

35678 Radiation-enhanced creep. Nichols, F.A. pp 267-294 of Radiation damage in metals. Peterson, N.L.; Harkness, S.D. (eds.). Metals Park, OH; American Society for Metals (1976).

From Conference on radiation damage in metals; Cincinnati, OH, USA (9 Nov 1975).

See CONF-751164—.

An overall interpretation of radiation creep in alloys is presented. At low stresses (i.e., below unirradiated yield) it is suggested that radiation creep occurs primarily due to the formation of point defect loops, preferentially oriented with respect to the applied stress. Concurrently, radiation growth occurs in annealed crystals of less-than-cubic-symmetry and in cold-worked crystals of all symmetries due to either loops preferentially oriented with respect to internal stresses, or flux-induced climb of dislocations with preferentially oriented Burger's vectors, or both. Radiation growth necessarily produces yielding creep but this is believed to contribute less than the preferential loop alignment process in most cases. (GHT)

35679 Irradiation strengthening and embrittlement. Bloom, E.E. (Oak Ridge National Lab., TN). pp 295-329 of Radiation damage in metals. Peterson, N.L.; Harkness, S.D. (eds.). Metals Park, OH; American Society for Metals (1976).

From Conference on radiation damage in metals; Cincinnati, OH, USA (9 Nov 1975).

See CONF-751164—.

The most complete body of experimental data on irradiation strengthening and embrittlement is for the austenitic stainless steels. In these alloys the changes in strength, deformation behavior, fracture behavior, and ductility that occur as a result of neutron irradiation can be directly related to the microstructural changes produced by the irradiation. At low temperatures, less than 0.35 T/sub m/ (350°C), irradiation-produced dislocation loops increase flow stress, reduce uniform strain, and at high damage levels change the mode of deformation (homogeneous deformation) to localized planar or channel deformation. In the range 0.35 T/sub m/ to 0.60 T/sub m/ (350 to 700°C) voids and a dislocation structure are formed. At high stress levels (producing strain rates normally encountered in a tensile test) the effects on flow properties and deformation behavior are similar to those at low temperatures. When the density decrease due to void formation is large a new fracture mode appears: fracture occurs along the deformation channels (channel fracture). At lower stress levels (creep deformation) fractures become intergranular. Strain-time curves and observations of crack propagation suggest that a crack grows to a critical size and then propagates in an unstable manner. Important factors in this behavior appear to be lattice hardening, which reduces plastic deformation at the crack tip, and changes in grain boundary composition (segregation of helium), which further reduce the energy required to propagate the crack along the boundary. At high temperatures, greater than 0.60 T/sub m/ (700°C), no displacement damage is stable and flow properties are unaffected. However, at these temperatures strength properties may be altered by second phase precipitation. Although irradiation does not drastically alter the fracture mode the rupture life and ductility are reduced by the increased concentration of cavity nuclei (helium bubbles) at grain boundaries.

CERAMICS, CERMETS, AND REFRACTORIES

REFER ALSO TO CITATION(S) 34327, 35541, 35542, 35789

PREPARATION AND FABRICATION

REFER ALSO TO CITATION(S) 34748

35680 (LBL—7322) **Quantizing the polarization of lead zirconate—titanate.** Hewett, S.W. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Dec 1977. Contract W-7405-ENG-48. 38p. Dep. NTIS, PC A03/MF A01.

The polarization of polycrystalline lead zirconate-titanate ceramics was investigated. Thin disks were sintered from compacts of calcined lead zirconate-titanate with various stoichiometry and dopants. A packing powder technique was used to control lead oxide loss during firing. The charge displaced during poling was measured using a Sawyer-Tower circuit at various poling temperatures. The resonant and antiresonant frequencies were measured 24 hrs. after poling to determine the planar coupling coefficient and mechanical quality factor for all samples. It is shown that the saturation polarization for all undoped samples is 161 $\mu C/cm^2$ regardless of the poling temperature. This value is 82% of the saturation polarization estimated for a single crystal. The piezoelectric constants show no correlation with poling temperature in the range studied as long as saturation polarization is achieved. The electric field required for saturation polarization was plotted against temperature so that the required field could be estimated at any given temperature.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 35687

35681 (CONF-770913—7) **Phonon dispersion relation of uranium nitrate above and below the Neel temperature.** Dolling, G.; Holden, T.M.; Evensson, E.C.; Buyers, W.J.L.; Lander, G.H. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 11p. Dep. NTIS, PC A02/MF A01.

From International conference on lattice dynamics; Paris, France (5 Sep 1977).

Neutron coherent inelastic scattering measurements have been made of the phonon dispersion relation of uranium nitride both above and below the Neel temperature T/sub N/ = 50 K. Within the precision of the measurements, about 1% in frequency and 10% in line width and in scattered neutron intensity, no significant changes in these phonon properties were observed as a function of temperature other than those arising from population factor changes and a small stiffening of the lattice as the temperature decreases. At 4.2 K, two acoustic and two optic branches have been determined for each of the [001], [110] and [111] directions. The optic mode measurements revealed (a) a 20% variation in frequency across the Brillouin zone and (b) an interesting disposition of the LO and TO modes, such that nu/sub LO/ > nu/sub TO/ along [001] and [110],

while the reverse is true along the [111] directions. Within the experimental resolution, the LO and TO modes are degenerate near q = 0. We have been unable to obtain any satisfactory description of these results on the basis of conventional theoretical treatments (e.g. rigid-ion or shell models). Other possible interpretations of the results are discussed.

35682 (LBL—6985) **Structure of grain boundaries in silicon nitride based alloys.** Clarke, D.R.; Thomas, G. (Rockwell International Corp., Thousand Oaks, Calif. (USA). Science Center; California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Dec 1977. Contract W-7405-ENG-48. 21p. (CONF-771137—3). Dep. NTIS, PC A02/MF A01.

From 14. conference on ceramic science) processing of crystalline ceramics; Raleigh, NC, USA (7 Nov 1977).

Grain boundaries in silicon-based ceramics have been characterized by high resolution electron microscopy including the technique of lattice fringe imaging, and this work is illustrated with exxamples from both hot-pressed silicon nitrides (MgO and Y_2O_3 fluxed) and a magnesium-sialon (Mg_{1-86} Si_{1-67} Al_{2-47} O_{3-19} N_{3-81}). Room temperature observations of the glassy phase are consistent with it being only a partially wetting phase, indicating that it cannot form a continuous film. The atomic configuration of the grain boundaries in both materials is presented together with lattice fringe observations of segregation at grain boundaries in the magnesium-sialon.

35683 **Crystal field properties of $Yb_2Ti_2O_7$.** Dunlap, B.D.; Shenoy, G.K.; Friedt, J.M.; Meyer, M.; McCarthy, G.J. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Appl. Phys.;* **49**: No. 3, 1448-1449(Mar 1978).

Electronic properties of Yb^{3+} in $Yb_2Ti_2O_7$ have been investigated using the 84.6 keV Moessbauer transition in ^{170}Yb. The crystal field parameters have been deduced by analyzing spectra taken in various externally applied magnetic fields up to 32 kG at temperatures of 4.2 K and 1.6 K. Because of the hexagonal point symmetry at the Yb ion, the crystal field levels are sensitive to the direction of the applied field relative to the c axis. As a result, a proper discussion of the field and temperature dependence of the hyperfine parameters is not possible for a powder sample without a careful average over angles. Such an analysis then yields a value for the crystal field parameter B^0_2 in the range 15—21 K and B^0_4/B^0_2 ≈0.01. These parameters and the resulting crystal field eigenfunctions have been used to explain the small quadrupole interaction present in this material.

35684 **XPS study of $LaCoO_3$.** Veal, B.W.; Lam, D.J. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Appl. Phys.;* **49**: No. 3, 1461-1462(Mar 1978).

X-ray photoelectron spectroscopy (XPS) measurements have been performed on $LaCoO_3$ and related compounds including $LaTiO_3$ and $LaCrO_3$. The XPS spectra of $LaCoO_3$ are analyzed to determine the spin states of the Co ions. Final state multiplets of the d^6 electron configuration in the valence band region are apparent near the band edge. The predominately O 2p valence bands are corrected using XPS data from $LaTiO_3$ and $LaCrO_3$ where the 3d electron spectra are understood. The results are discussed in terms of the mixed spin-state trivalent cobalt ion model.

35685 **Pressure dependence of the melting temperature of tungsten carbide up to 80 kbar.** Vereshchagin, L.F.; Fateeva, N.S.; Magnitskaya, M.V. (Institute of High-Pressure Physics, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **26**: No. 4, 207-209(20 Aug 1977).

The pressure dependence of the melting point of tungsten carbide (WC) was investigated up to 80 kbar in the high-pressure chamber described by us earlier./sup / The investigated sample was placed in this experiment inside the working part of the chamber, which was equipped with lateral viewing windows. The pressure was produced in the chamber by pistons moving towards each other. The pressure generator was a 300-ton hydraulic press. The pressure-transmitting medium, in which the sample was directly placed was rock salt. The stepped windows in the chamber wall were filled with rock salt. The pressure calibration of the setup was based on polymorphic transitions in bismuth, thallium, and barium in accord with the 1968 scale./sup /

35686 **Some ternary oxides of neptunium and plutonium with the alkali metals.** Hoekstra, H.R.; Gebert, E. (Argonne National Lab., Ill. (USA)). *J. Inorg. Nucl. Chem.;* **39**: No. 12, 2219-2221(1977).

Crystal data and thermal stabilities are reported for ternary oxides formed by potassium, rubidium and cesium with neptunium and plutonium(VI). The compounds characterized include M_2NpO_4, $M_2Np_2O_7$ and M_2PuO_4 (where M = K, Rb and Cs), $Cs_4Np_5O_{17}$ and $Cs_2Np_3O_{10}$. A reinvestigation of the lithium-neptunium(VI) oxide system has demonstrated the existence of Li_2NpO_4.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 35005

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 34694

35687 (ORNL—5309, pp 273-281) **Eu_2O_3—W cermet development.** Pasto, A.E. Nov 1977.

In Liquid Metal Fast Breeder Reactor Materials Development Program. Quarterly progress report for period ending March 31, 1977.

Development of high-density Eu_2O_3—W cermets continued in several areas this quarter. Preliminary values for the thermal expansion of a cermet have been obtained, a data set of density versus hot-pressing temperature for powder-blend-prepared (PB) cermets was obtained, and some unique and perhaps troublesome observations were made on cermet microstructure. 4 figures, 2 tables. (RWR)

35688 **Magnetic and superconducting transitions in Gd/sub x/Er/sub 1-x/Rh_4B_4 and Gd/sub x/Y/sub 1-x/Rh_4B_4.** Wang, R.H.; Laskowski, R.J.; Huang, C.Y.; Smith, J.L.; Chu, C.W. (Los Alamos Scientific Laboratory of the University of California, Los Alamos, New Mexico 87545). *J. Appl. Phys.;* **49**: No. 3, 1392-1394(Mar 1978).

The magnetic and superconducting transition temperatures and upper critical fields have been measured for Gd/sub x/Er/sub 1-x/Rh_4B_4 and Gd/sub x/Y/sub 1-x/Rh_4B_4. The pressure dependence of T/sub c/ for the Er system for x< or =0.05 is 0.5 x 10^{-3} K/kbar. Both systems exhibit reentrant behavior, that is a superconducting transition followed by a magnetic transition at a lower temperature that destroys the superconductivity. For the Er system, the initial additions of Gd actually raise the superconducting critical field followed by the expected decrease for greater additions.

35689 **Effects of dilute Pt on the Gd^{3+} ESR lineshape in ScH/sub 1.9/.** Venturini, E.L. (Sandia Laboratories, Albuquerque, New Mexico 87115). *J. Appl. Phys.;* **49**: No. 3, 1492-1494(Mar 1978).

Gd^{3+} electron spin resonance (ESR) at 9.8 GHz has been studied from liquid helium to liquid nitrogen temperatures in a metallic scandium dihydride host containing 0.5 atomic percent Gd and from 0 to 1 atomic percent Pt. The sample without the Pt has a residual or zero-temperature linewidth of 180 +- 5 Oe and a g-factor of 1.993 +- 0.003. The addition of nonmagnetic Pt impurities has little effect on the slope of the ESR linewidth versus temperature or on the position of the line center (g-factor), but it drastically reduces the residual linewidth. For a sample containing 0.25 atomic percent Pt the residual linewidth is 71 +- 3 Oe, less than 40% of that for the sample without Pt. A careful analysis of the ESR lineshape shows that it is neither Lorentzian nor a combination of Gaussian and Lorentzian components. We can accurately describe the experimental shape using a Lorentzian function with a single center and a half-width uniformly distributed between a minimum and maximum value. Using this model for the Gd^{3+} ESR lineshape, we find that the addition of nonmagnetic Pt impurities sharply reduces the maximum half-width of the distribution while producing a much smaller change in the minimum half-width.

35690 **Determination of the optical characteristics of V_2O_5 crystals through the transmission spectra in the far IR region.** Abdullaev, A.A.; Belyaev, L.M.; Dobrzhanskii, G.F.; Kalgin, Y.A. (Institute of Crystallography, Academy of Sciences of the USSR). *Sov. Phys. - Crystallogr. (Engl. Transl.);* **22**: No. 5, 628-629(Sep 1977).

Single crystals of V_2O_5 are grown from the melt and the complex refractive index is determined by analysis of far infrared transmission and reflectance spectra.

CORROSION AND EROSION

REFER ALSO TO CITATION(S) 35640

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 35047, 35674, 35675

COMPOSITE MATERIALS

MECHANICAL PROPERTIES

35691 (ORNL/TM—5493) **System for vacuum pouring of epoxy tensile and impact specimens with a study of the behavior of these specimens at 77 K and 293 K.** Fitzpatrick, C.M.; Stoddart, W.C.T. (Oak Ridge National Lab., Tenn. (USA)). Mar 1978. Contract W-7405-ENG-26. 11p. Dep. NTIS, PC A02/MF A01.

The purpose of the investigation described in this report was to establish a suitable technique for vacuum pouring of epoxy test

specimens and to study the behavior of these specimens at 77 K and 293 K. A series of tensile and impact tests was conducted using specimens made from the following resins: Epon 828, Epon 871, and Epon curing agent Z. These materials are of general interest to designers of magnets for cryogenic service. Some of the applications that may be considered are: structural support, spacing, electrical insulation, and thermal insulation. The epoxies mentioned above were selected for more extensive testing because they have been used successfully, at room temperature in EBT and ORMAK programs in the Fusion Energy Division at Oak Ridge National Laboratory. Liquid nitrogen was chosen over liquid helium because it is less difficult to handle, less expensive, and in most instances physical properties of epoxies seem to change very little from 77 K to 4.2 K. The two main features of the vacuum pouring apparatus are (1) batches can be poured under near-identical conditions, and (2) samples can be handled free from air contamination. Tests of the specimens were carried out at 77 K and 293 K. The 77 K data indicate that tensile strength increases proportionally with the increase of Epon 871 relative to Epon 828. When the mixture includes more than 90% Epon 871, impact testing at 293 K becomes practically impossible due to the rubbery condition of the material. However, when tested at 77 K, this same mixture evinces high tensile strength. When optimum data are sought over a wide range of temperatures, 77 K to 293 K, it appears that a mixture of 70% Epon 871, 30% Epon 838 with 13 ppH curing agent Z offers the best compromise in tensile strength, modulus of elasticity and impact resistance.

POLYMERS AND PLASTICS

PREPARATION AND FABRICATION

35692 (BDX—613-1725(Rev.)) **Mechanical properties of 0.2 g/cm³ polystyrene bead foam.** Fossey, D.J. (Bendix Corp., Kansas City, Mo. (USA)). Jan 1978. Contract EY-76-C-04-0613. 23p. Dep. NTIS, PC A02/MF A01.

In order to better interpret the results from a strain gage investigation of the effects of stress induced by polystyrene bead foam (PSBF) on electronic devices, the tensile and compressive properties of 0.2 g/cm³ potting PSBF needed to be determined. These data are also required for mathematical models being employed to predict the force PSBF may exert on components. The properties were determined to be a function of temperature and residual pentane (blowing agent) content at -54°, 25°, and 74°C. Both as-molded pentane content (1.4%) and heat-aged pentane content (less than 0.2%) were evaluated. Five specimens were tested at each condition. The material evaluated was BF-61 expandable polystyrene bead obtained from the BASF Corporation and molded to simulate the foam used for potting electronic components.

35693 (BDX—613-1836(Rev.)) **Material evaluation of polyurethane foam, 0.05 g/cm³ density.** Fender, J.R. (Bendix Corp., Kansas City, Mo. (USA)). Mar 1978. Contract EY-76-C-04-0613. 57p. Dep. NTIS, PC A04/MF A01.

Rigifoam 6003-2, a Bendix manufactured CO_2-blown polyester polyurethane foam system, was chosen for use as the prime material for production of parts with a foam density of 0.05 g/cm³. Studies of the 6003-2 physical properties, chemical analysis, dimensional stability, moisture content, and the machining and gaging capabilities of this material are summarized. The next phase of this project will include the development of processing and stabilization techniques required to consistently fabricate quality foam billets which have no rejectable voids or streaks.

MECHANICAL PROPERTIES

REFER ALSO TO CITATION(S) 35693

35694 (BDX—613-1905(Rev.)) **Investigation of methylpentene polymer (TPX) molding resin. Final report.** Walter, C.L. (Bendix Corp., Kansas City, Mo. (USA)). Mar 1978. Contract EY-76-C-04-0613. 22p. Dep. NTIS, PC A02/MF A01.

A polymethylpentene polymer (TPX) produced by Mitsui Petrochemical Industries, Ltd., Japan, was evaluated and compared to a TPX previously obtained from Imperial Chemical Industries, Ltd., England, who no longer produce TPX and have sold their manufacturing process for this polymer to Mitsui. The rheological, chemical, and physical properties of the materials were compared and the two materials were found to be essentially identical.

PHYSICAL PROPERTIES

REFER ALSO TO CITATION(S) 35693

OTHER MATERIALS

PREPARATION AND MANUFACTURE

REFER ALSO TO CITATION(S) 34730, 35705

35695 **Technique for bonding gold and silver metals on sapphire.** Varmazis, C.; Viswanathan, R.; Caton, R. (Brookhaven National Laboratory, Upton, New York 11973). *Rev. Sci. Instrum.;* **49**: No. 4, 549-550(Apr 1978).

A technique is described for bonding gold and silver metals onto sapphire. This technique has been successfully used in ac calorimetry for heat capacity of films.

STRUCTURE AND PHASE STUDIES

REFER ALSO TO CITATION(S) 35561

35696 **Auger-electron spectroscopy as a local probe of atomic charge: SiL/sub 2.3/VV.** Jennison, D.R. (Sandia Laboratories, Albuquerque, New Mexico 87115). *Phys. Rev. Lett.;* **40**: No. 12, 807-809(20 Mar 1978).

Auger-electron spectroscopy is shown to measured something quite different from photoemission: the distribution of atomic (as opposed to overlap) charge populations across the valence bands. While matrix-elements effects must be considered in s-p band materials, their inclusion in calculations still lead to poor agreement with experiment. Good agreement may obtained, however, if one divides the electronic charge into atomic and overlap (bonding) LCAO components and notes that the latter does not contribute to the Auger current.

35697 **Structural fluctuations in NbO_2 at high temperatures.** Pynn, R.; Axe, J.D.; Raccah, P.M. (Physics Department, Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., B;* **17**: No. 5, 2196-2205(1 Mar 1978).

Inelastic neutron scattering has been used to study the fluctuations associated with the structural phase transformation at T/sub c/ = 808.5 °C in NbO_2. Above T/sub c/ there is strong quasielastic scattering centered upon the reciprocal-lattice position q/sub p/ = (1/4,1/4,1/2), but lying along rods oriented parallel to [110] directions. The temperature dependence of the anisotropic correction length and energy widths have been determined. We show that the structural fluctuations consist of strong-coupled antiferrodistortive distortions within (110) planes in the parent rutile structure with much weaker correlations of the fluctuations from plane to plane. A simple mean-field pseudospin treatment can be used to discuss the data semiquantitatively and aids in understanding the relationship between the structural instabilities in NbO_2 and its isoelectronic compound VO_2. No evidence was found for a soft-phonon branch.

35698 **Pressure-induced strain transition in NiF_2.** Jorgensen, J.D.; Worlton, T.G.; Jamieson, J.C. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., B;* **17**: No. 5, 2212-2214(1 Mar 1978).

We report time-of-flight neutron powder diffraction measurements which give the first direct evidence that NiF_2 undergoes a pressure-induced, continuous phase transition from tetragonal $P4_2/mnm$ (rutile) to orthorhombic Pnnm at 18.3 +- 1 kbar. The square of the strain (b - a) varies linearly with pressure above the transition and extrapolates to zero at the transition pressure. Measured atomic positions and thermal displacements show that motion of the F atoms is responsible for the transition.

35699 **Pressure dependence of crystal field splitting in Pr pnictides and chalcogenides.** Schirber, J.E.; Weaver, H.T.; Ginley, D.S. (Sandia Laboratories, Albuquerque, New Mexico 87115). *J. Appl. Phys.;* **49**: No. 3, 1469-1470(Mar 1978).

We have measured the pressure dependence of the Pr nuclear magnetic resonance shift in PrN, PrP, PrSb, PrAs, PrS and PrSe. The shifts in all the pnictides increase while in the chalcogenides the shifts decrease with pressure. The rare earth frequency shift is inversely proportional to the crystal field splitting in the context of the point charge model (PCM) so a decrease would be expected for all of these materials at a rate of 5/3 the volume compressibility. Our values for the pnictides tend to be considerably larger than the PCM value as well as the wrong sign. The chalcogenide values are much nearer in magnitude and are of the right sign for the PCM. Contrary to the report of Guertin et al. we see no anomaly in the pressure dependence of the susceptibility of PrS. The fact that PrN which is reported to be non-metallic also shows the wrong sign for the PCM presents difficulties for various conduction electron explanations for this unexpected behavior of the pnictides.

35700 **Coherent potential approximation treatment of intermediate valence in rare-earth compounds induced by alloying.** Schweitzer, J.W. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Appl. Phys.;* **49**: No. 3, 2090-2092(Mar 1978).

The coherent potential approximation (CPA) is applied to the description of intermediate valence induced by alloying as observed in the solid solutions Sm/sub 1-x/R/sub x/S where R denotes a rare-earth element which is trivalent in the monosulfide. The description is based on the Falicov-Kimball model for metal-insulator transitions generalized to take into account the disorder associated with the R substitution. This disorder is treated within the CPA while the intra-atomic correlation on the Sm sites is also treated by the CPA in analogy with an alloy of divalent and trivalent Sm ions. The transition to an intermediate valence for Sm as a function of alloy composition is discussed in terms of the results of this treatment.

35701 Isotope effect on the electronic spin density in PdH superconductor. Jena, P.; Wiley, C.L.; Fradin, F.Y. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev. Lett.;* **40**: No. 9, 578-581(27 Feb 1978).

The nuclear spin-lattice relaxation rates of ^1H and ^2D in stoichiometric PdH and PdD indicate a significant increase in the spin density at the deutron site over that at proton site. The results are analyzed theoretically in two distinctly different models involving the zero-point vibrations of the hydrogen. The implication of these results for the understanding of the reverse isotope effect on T/sub c/ is discussed.

35702 Isotope shifts in the ground state of shallow, hydrogenic centers in pure germanium. Haller, E.E. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev. Lett.;* **40**: No. 9, 584-586(27 Feb 1978).

Large isotope shifts in the ground state of an acceptor A_2 (E/sub val/ + 11.31 meV) and a donor D (E/sub cond/-12.34 meV) have been observed for the first time with photoelectric spectroscopy in pure germanium. The shifts (ΔE/sup A/2 = + 21 +- 3μeV;ΔE/sup D/ = - 51 +- 3μeV) occur in germanium crystals grown in deuterium instead of hydrogen. A_2 and D are observed at concentrations $< 4 \times 10^{11}$ cm^{-3}. The isotope shift is a direct proof that the centers A_2 and D contain hydrogen.

35703 Theory of Auger line shapes in chemisorption of Cl on Si(111). Feibelman, P.J.; McGuire, E.J.; Pandey, K.C. (Sandia Laboratories, Albuquerque, New Mexico 87115). *Phys. Rev., B;* **17**: No. 4, 1799-1807(15 Feb 1978).

L_1L/sub 2,3/V and L/sub 2,3/VV Auger line shapes have been calculated for Cl and Si in the adsorption system Si(111) -Cl(1 x 1), based on an empirical tight-binding surface band-structure calculation. The fact that Cl and Si orbitals do not mix strongly means that the local densities of states (LDOS) at the Cl and Si atoms are very different; this difference is reflected in the predicted Cl and Si Auger spectra, and its experimental observation would be of considerable interest, as a demonstration that Auger spectra can provide local electronic structure information. The Si L_1L/sub 2,3/V spectra from clean and Cl-covered Si(111) will probably not be different enough, because of the breadth of the Si 2s level, to permit one to obtain useful information from their difference. However, if one uses a grazing incidence beam to enhance the contributions of the outermost Si layers, the differences between the Si L/sub 2,3/VV spectra for the clean and covered surfaces should be quite prominent, and will reflect the changes in the Si electron energy distribution induced by the formation of strong σ- and weak π-bonds with the Cl. The calculated Cl spectra decompose readily into contributions from the s- and p-like components of the Cl LDOS and from convolutions of them, a fact which will permit the experimental determination of Auger matrix-element angular-momentum dependence.

PROPERTIES

REFER ALSO TO CITATION(S) 34607, 36201

35704 (LBL—6016, pp 292-294) **Physical chemistry with emphasis on thermodynamic properties.** Pitzer, K.S. 1976.

In Materials and Molecular Research Division annual report, 1976.

Research activities in physical chemistry, with emphasis on thermodynamic properties, at Lawrence Berkeley Laboratory during 1976 are described. Topics covered include: quantum chemistry for heavy atoms; solutions of electrolytes at high temperatures; and thermodynamic properties of sulfuric acid. (GHT)

35705 (MHSMP—76-7C) **90503 mock study. Period covered: October—December 1975.** Crutchmer, J.A.; Johnson, H.D. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1976. Contract W-7405-ENG-48. 36p. Dep. NTIS, PC A03/MF A01.

Two billets were pressed from each of three lots of 90503 mock. One billet from each of these lots was pressed using dried powder. Samples were taken from each pressing charge just prior to pressing and volatile content measured. Each of these six billets were then machined into compression and tensile specimens. Additional compression specimens were machined from an existing hemispherical part made from one of these lots of material. Dimensional stability tests were conducted on parts from each billet and the hemisphere. Compression and tensile testing was conducted at 21 C and 49 C on specimens from each of the six billets. The small scale compression specimens from the hemisphere were also tested at these temperatures. The mechanical properties testing shows that the compression strain at rupture and the tensile rupture stress were significantly affected by the higher temperature. No apparent differences were seen between parts made from dried or normal powder.

35706 Hydrated proton $H^+(H_2O)$/sub n/. VII.)/sup a/ A neutron diffraction study of the isolated diaquooxonium ion $H_3O^+ x2H_2O$in 2,5-dichlorobenzenesulphonic acid trihydrate. Roziere, J.; Williams, J.M. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* **68**: No. 6, 2896-2901(15 Mar 1978).

A neutron diffraction study of 2,5-dichlorobenzenesulphonic acid trihydrate has been undertaken in order to investigate the precise hydrogen atom arrangement within the "$H_7O^+_3$" unit. The cationic species can be unambiguously formulated as $H_3O^+ x2H_2O$,the diaquooxonium ion, although the hydrogen bond distances are short and comparable to those found in diaquohydrogen ions, $(H_2OxHxOH_2)^+$. Considerable asymmetry is observed in these hydrogen bonds. The oxonium ion geometry is highly distorted from trigonal symmetry, with dO-H of 1.08(2), 0.98(1), and 0.94(2) A,and the ion is quite flat. The derived H_3O^+ ion geometry, and the high thermal motion of the oxygen atom, may indicate some sort of disorder involving oxonium ion inversion. The structure was determined using 1906 independent three dimensional data measured with a neutron wavelength of 1.142(1) A. The crystals are monoclinic, space group P2/sub 1/c/ with unit cell dimension (x-ray) a=7.350(2) A,b=23.516(3) A, c=6.862(1) A, and β=100.68(4) °. The structure was refined by full matrix least-squares techniques on F^2/sub o/, with anisotropic thermal parameters for all atoms, to R=0.089.

35707 Neutron diffraction study of magnetic order in the ternary superconductor $ErMo_6Se_8$. Lynn, J.W.; Moncton, D.E.; Shirane, G.; Thomlinson, W.; Eckert, J.; Shelton, R.N. (Department of Physics, University of Maryland, College Park, Maryland 20742). *J. Appl. Phys.;* **49**: No. 3, 1389-1391(Mar 1978).

Development of new ternary superconductors has led to materials which also show a strong tendency toward magnetic order when one of the constituent elements is a rare earth. Powder neutron diffraction data on superconducting (T/sub s/~6 K) samples of $ErMo_6Se_8$ taken in the temperature range 0.05—2.0 K show that magnetic Bragg peaks develop at T/sub M/=1.1 K, in agreement with specific heat studies. However, it is not possible to index these new reflections using a simple antiferromagnetic unit cell based on the $ErMo_6Se_8$ lattice. It is also not possible to index the magnetic reflections based on a single modulation vector, or with a modulation vector along a high symmetry direction including higher order harmonics. Thus either the long range magnetic order corresponds to a more complicated magnetic structure in the $ErMo_6Se_8$ lattice, or at least some of the peaks develop in impurity phases. These results are compared with the recent neutron data on the reentrant superconductors $HoMo_6Se_8$ and $ErRh_4B_4$, in which the development of ferromagnetic order is clearly shown to be responsible for quenching the superconductivity.

35708 Magnetic excitations in amorphous ferromagnets. Mook, H.A. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Appl. Phys.;* **49**: No. 3, 1665-1670(Mar 1978).

Neutron scattering techniques have been used to measure the static structure and magnetic excitations in amorphous magnets. Sum rules and computer models are used to discuss the relationship between the static disorder and the shape of the excitation spectrum. Polarized beam measurements of chi"(Q,E) are compared to analytical theories and computer calculations for the magnetic excitations in amorphous ferromagnets.

35709 Induced magnetic form factor of Sm in mixed-valence compounds. Moon, R.M.; Koehler, W.C.; McWhan, D.B.; Holtzberg, F. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Appl. Phys.;* **49**: No. 3, 2107-2112(Mar 1978).

The induced moment form factor of Sm has been measured in a number of compounds using the polarized neutron technique. For integral-valence compounds, experimental and theoretical evidence is presented showing that Sm^{2+} and Sm^{3+} usually have large differences in their form factors. For the mixed-valence systems, SmS at high pressure and Sm/sub 0.76/Y/sub 0.24/S, the observed form factor is nearly identical to that of the 2+ ion. If we adopt the viewpoint that the Sm ions are fluctuating between $4f^5$ and $4f^6$ configurations, then our measurements imply that the induced moment from the $4f^5$ configuration is dominated by the Van Vleck contribution to the susceptibility arising from an admixture of states with different J values or that the $4f^5$ configuration makes a negligible contribution to the form factor. The suppression of the Curie (1/T) terms is consistent with low-temperature susceptibility measurements on these systems. The implications of these observations are examined within the framework of a simple valence-fluctuation model.

35710 Magnetic, optical, and magneto-optical behavior of $LiTbF_4$ and KTb_3F_{10} crystals. Griffin, J.A.; Folkins, J.; Weber, M.J.; Morgret, R.; Litster, J.D.; Gabbe, D.; Linz, A. (Department of Physics, Laboratory for Research on the Structure of Matter, University of Pennsylvania, Philadelphia, Pennsylvania 19104). *J. Appl. Phys.;* **49**: No. 3, 2209-2211(Mar 1978).

The magnetic, optical, and magneto-optical behavior of the crystals $LiTbF_4$, LiTb/sub 0.5/Y/sub 0.5/F_4, LiTb/sub 0.25/Gd/sub 0.75/F_4, and KTb_3F_{10} have been measured. We present the temperature, wavelength, and magnetic field dependence of the Faraday rotation in these materials and the wavelength dependence of the optical absorption. The magnetic ordering found in these crystals and its relation to optical phenomena is also discussed.

35711 Band structure and lattice instability of $TiSe_2$. Zunger, A.; Freeman, A.J. (Department of Physics and Astronomy and Materials Research Center, Northwestern University, Evanston, Illinois 60201). *Phys. Rev., B;* **17**: No. 4, 1839-1842(15 Feb 1978).

The energy band structure of $TiSe_2$, determined in the local-density approach yields a semimetal (band overlap 0.20 +- 0.05 eV) with holes at Γ and electron pockets only at L. The dimensions of the electron pocket indicate the presence of (7-8) x 10^{20} carriers/cm^3 in excellent agreement with both transport and angular-resolved photoemission data. The observed charge-density wave is attributed to characteristic "volume" effects, i.e., nesting of parallel electron-hole bands at E/sub F/ separated by the Γ-L zone-boundary wave vector.

35712 Effect of pressure on ionic conductivity in rubidium silver iodide and silver iodide. Allen, P.C.; Lazarus, D. (Department of Physics and Materials Research Laboratory, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801). *Phys. Rev., B;* **17**: No. 4, 1913-1927(15 Feb 1978).

The effect of pressure on the ionic conductivity of $RbAg_4I_5$ and AgI has been measured, using single crystals and polycrystalline samples, up to pressures of 6 kbar. The activation volumes for motion in α-$RbAg_4I_5$ and β-$RbAg_4I_5$, respectively, are -0.4 +- 0.2 and -0.2 +- 0.1 cm^3/mole. In α-AgI, the motion volume increases from 0.56 +- 0.1 cm^3/mole at 435 K to 0.8 +- 0.1 cm^3/mole at 623 K. These values are unusually small in relation to the activation energies and are not consistent with the strain-energy model or a domain-diffusion mechanism. The logarithms of the ionic conductivities of α- and β-$RbAg_4I_5$ increase linearly at first and then decrease quadratically with pressure. This is related to the large quadratic pressure dependence of the second-order transition temperature ΔT/sub c/(K) = 0.141P(kbar) + 0.111P^2($kbar^2$). The variation of the 122-K transition temperature with pressure is ΔT/sub c/(K) = 5.65P(kbar)-0.53P^2($kbar^2$), implying a molar volume change of V/sub β/γ = 0.37 +- 0.01 cm^3/mole and a change in compressibility K/sub β/γ = (0.033 +- 0.001) x 10^{-11} cm^2/dyn across the transition. The ionic conductivity of γ-$RbAg_4I_5$ initially decreases with an activation volume of 9 +- 1 cm^3/mole, and then levels off with increasing pressure. The negative activation volume for conduction along the c axis in β-AgI has been confirmed. Both low-temperature phases have large formation volumes consistent with the theory of Rice et al. of transitions to the superionic phase.

35713 Intrinsic luminescence excitation spectrum and extended x-ray absorption fine structure above the K edge in CaF_2. Bianconi, A.; Jackson, D.; Monahan, K. (Stanford Synchrotron Radiation Project and Department of Applied Physics, Stanford University, Stanford, California 94305). *Phys. Rev., B;* **17**: No. 4, 2021-2024(15 Feb 1978).

Excitation spectra of the 4.44-eV intrinsic luminescence in a single crystal of CaF_2 at liquid-nitrogen temperature was measured using synchrotron radiation in the x-ray region. The intrinsic luminescence at 4.44 eV is due to self-trapped exciton recombination. The intensity of the emitted uv light was measured as a function of the x-ray photon energy from below the calcium K edge to 200 eV above the edge. Dips were observed in the luminescence excitation spectrum corresponding to peaks in the absorption coefficient both in the core excitation region near the edge and in the region of excitation to the continuum far above the edge. The effect is correlated with modulation of the radiative recombination probability of the core hole. The close relationship between the inverse of the luminescence yield and the extended x-ray absorption fine structure (EXAFS) after background subtraction shows that excitation spectra of uv luminescence can be used to measure EXAFS in thick single crystals and biological samples with suitable luminescence centers.

CORROSION, EROSION, AND DEGRADATION

35714 (ORNL-tr—4580) **Tests of steel cladding of graphite vortex plates.** Kirner, K. (Bosch (R.) G.m.b.H., Gerlingen (Germany, F.R.)). Aug 1976. Translation by K. Holland of BMFT-FB-W—76-12. 40p. Dep. NTIS, PC A03/MF A01.

Coatings to improve the ablation (erosion + burning + vaporization) properties of graphite for use in rocket engines were tested. The coated graphite was tested with various coatings which were applied by plasma arc spraying. Combustion temperatures approached 4500°K. (GHT)

35715 (ORNL-tr—4603) **Acid-resistant Ocrat concrete.** Wittekindt, W. Translated by S.D. Blalock Jr. from *Zem.-Kalk-Gips;* **7**: No. 1, 337-342(1954). 13p. Dep. NTIS, PC A02/MF A01.

The technical equipment required for the ocrating of concrete is described. The qualities of a concrete having undergone SiF_4 gas treatment and thus becoming acid-resisting are explained in detail and the reactions of ocrated concrete as compared to the non-ocrated one are discussed with regard to the strength figures. (GHT)

RADIATION EFFECTS

REFER ALSO TO CITATION(S) 35082, 35674, 35675

35716 Characterization of molecular defects in crystals by polarization analysis of resonance Raman scattering: Metastable O_2^* in γ-irradiated $NaClO_3$. Engstrom, H. (Brookhaven National Laboratory, Upton, New York, 11973). *J. Chem. Phys.;* **68**: No. 6, 2806-2813(15 Mar 1978).

Accurate measurements of the polarization of resonance Raman scattered light from a molecular defect have been made using a combination of polarization modulation and photon counting techniques. A systematic method of least squares analysis of data so obtained is presented. The method is applied to the metastable O_2^* molecule in γ-irradiated sodium chlorate. The results have permitted the determination of the directions of maximum polarizability and absorption of the defect.

CHEMISTRY

ANALYTICAL AND SEPARATIONS CHEMISTRY

REFER ALSO TO CITATION(S) 34402

35717 (COO—1198-1203) **Fully automated system for pulsed NMR measurements.** Cantor, D.M. (Illinois Univ., Urbana (USA). Dept. of Chemistry). 1977. Contract EY-76-C-02-1198. 148p. Dep. NTIS, PC A07/MF A01.

A system is described which places many of the complex, tedious operations for pulsed NMR experiments under computer control. It automatically optimizes the experiment parameters of pulse length and phase, and precision, accuracy, and measurement speed are improved. The hardware interface between the computer and the NMR instrument is described. Design features, justification of the choices made between alternative design strategies, and details of the implementation of design goals are presented. Software features common to all the available experiments are discussed. Optimization of pulse lengths and phases is performed via a sequential search technique called Uniplex. Measurements of the spin-lattice and spin-spin relaxation times and of diffusion constants are automatic. Options for expansion of the system are explored along with some of the limitations of the system.

35718 (LBL—6016, pp 241-269) **Chemical and geophysical energy.** 1976.

In Materials and Molecular Research Division annual report, 1976.

Research into the area of chemical energy at Lawrence Berkeley Laboratory during 1976 is described. Topics covered include formation of oxyacids of sulfur from SO_2; synthetic and physical chemistry; electrochemical systems; high energy oxidizers and delocalized-electron solids; and conversion of coal to clean liquid and gaseous fuels. (GHT)

35719 (UCRL—52356) **Analytical capabilities and services of Lawrence Livermore Laboratory's General Chemistry Division.** Gutmacher, R.; Crawford, R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 9 Mar 1978. Contract W-7405-ENG-48. 70p. Dep. NTIS, PC A04/MF A01.

This comprehensive guide to the analytical capabilities of Lawrence Livermore Laboratory's General Chemistry Division describes each analytical method in terms of its principle, field of application, and qualitative and quantitative uses. Also described are the state and quantity of sample required for analysis, processing time, available instrumentation, and responsible personnel.

ACTIVATION AND NUCLEAR REACTION PROCEDURES

REFER ALSO TO CITATION(S) 34398, 34568

35720 Neutron activation analytical determination of small amounts of ^{237}Np in solutions containing uranium, plutonium, and

fission products. Ruf, H.; Friedrich, M. (Kernforschungszentrum, Karlsruhe, Ger.). *Nucl. Technol.;* **37**: No. 1, 79-83(Jan 1978).

Submicrogram amounts of ^{237}Np in process solutions of the Karlsruhe MILLI plant were determined by neutron activation analysis after chemical separation from nuclear fuel elements and fission products by extraction with thenoyltrifluoroacetone. Chemical yield controls were established by adding and measuring of ^{239}Np spike activity.

CHEMICAL PROCEDURES

35721 3-quantum transition probabilities in the ν_3 manifold of UF_6 and the assignment of $3\nu_3$ in the observed infrared spectrum. Marcott, C.; Golden, W.G.; Overend, J. (Molecular Spectroscopy Laboratory, Department of Chemistry, University of Minnesota, Minneapolis, Minnesota 55455). *J. Chem. Phys.;* **68**: No. 6, 2929-2932(15 Mar 1978).

Although there are two F/sub 1u/ components in $3\nu_3$ of UF_6 and transitions are allowed from the vibrational ground state to both, only a single band has been observed in the ir spectrum. These two states may be identified in a Cartesian representation of the normal coordinates as 3ν/sub 3x/ and 2ν/sub 3x/$+\nu$/sub 3y/; on the basis of calculated intensities, the observed transition has been assigned to 3ν/sub 3x/. The calculation of the dipole strengths required us to derive the octahedral splitting parameters G_{33} and T_{33} and these have been used to calculate the anharmonic splittings in the ν_3 vibrational manifolds of $^{238}UF_6$ and $^{235}UF_6$.

35722 Determination of residual chlorine in water with computer automation and a residual-chlorine electrode. Rigdon, L.P.; Moody, G.J.; Frazer, J.W. (Univ. of California, Livermore). *Anal. Chem.;* **50**: No. 3, 465-469(Mar 1978).

A method of determining active chlorine in water in the concentration range 3 to 100 ppB with an accuracy of 2 ppB has been developed. The method uses the Orion model 97-70 residual-chlorine electrode and the known standard-addition potentiometric technique to measure the potential difference between iodide and iodine that is generated by active chlorine. The assay is computer-automated to carry out the multiple addition of a standard; measure the potentials; plot the potentiometric curve, its Gran version, and an error function; and calculate the concentration of active chlorine in the assay solution. The electrode, the chemical reactions that occur during the assay, the preparation and storage of standards, and the procedure are discussed. Data obtained from the assay of standards prepared from deionized water, two sources of public water supply, and one swimming pool are presented. 1 table, 8 figures.

35723 Improved miniature flow fluorometer for liquid chromatography. Thacker, L.H. (Oak Ridge National Lab., TN). *J. Chromatogr.;* **136**: 213-220(1977).

A simple, reliable, and inexpensive miniature flow fluorometer has been developed for use as a detector in liquid chromatography. The new instrument has been designed after approximately 15 years cumulative experience with a previously reported model. All of the desirable features of the earlier instrument are retained, and a number of simplifications and improvements have been added. These include three light-source alternatives for meeting a wide range of excitation requirements. For many applications a 1-10 ng limit of detection has been attained.

RADIOMETRIC AND RADIOCHEMICAL PROCEDURES

REFER ALSO TO CITATION(S) 34403, 35898

35724 (JAERI—1249) **Chemical analysis of nickel- and iron-base high-temperature alloys for nuclear reactor. Preparation of standard samples and development of analytical methods.** (Japan Atomic Energy Research Inst., Tokyo). Mar 1977. 219p. (In Japanese). Dep. NTIS (US Sales Only), PC A10/MF A01.

The Committee studied problems in analysis of alloys used for High-Temperature Gas Cooled Reactor from September 1970 to February 1976. The alloys selected from the standpoint of analytical chemistry are Inconel 600, Incoloy 800, Inconel X750, Inco 713C and Hastelloy X. Nine standard samples (JAERI-R 1 to JAERI-R 9) of the high-temperature alloys were prepared primarily for X-ray fluorescence method. Eighteen research institutions in Japan participated in cooperative analyses of the standard samples for 19 elements (C, Si, Mn, P, S, Ni, Cr, Fe, Mo, Cu, W, V, Co, Ti, Al, B, Nb, Ta, Zr). Prior to analyses of the standard samples, 8 cooperative samples (A-H) were analyzed to develop and evaluate analytical methods. Described in this report are preparation and their characteristics of the standard samples, results of analyses, and 93 analytical methods. The results of the cooperative experiments on atomic absorption spectrophotometry and X-ray fluorescence method are also described.

35725 (MLM-MU—77-68-0002) **Evaluation of calibration alternatives for the calorimetric assay of reactor grade PuO_2. Interim report.** Rogers, D.R.; Rodenburg, W.W. (Mound Lab., Miamisburg, Ohio (USA)). 31 Aug 1977. Contract EY-76-C-04-0053. 41p. Dep. NTIS, PC A03/MF A01.

Progress is reported on an experimental evaluation of five methods for determining the effective specific power of reactor grade plutonium dioxide. The experimental work is at least 50% complete and is proceeding without major difficulties. Analysis of the data collected to date indicate that the precision and accuracy of the better methods are comparable to standard plutonium assay methods such as coulometry. The basis between methods appear to be small and may result from the inaccuracy of the plutonium half-lives reported in ANSI N15.22-1975.

SPECTRAL PROCEDURES

REFER ALSO TO CITATION(S) 34518, 35917, 35918

35726 (ARH-LD—160) **Determination of low-level mercury by cold vapor generation and atomic absorption spectroscopy.** King, A.D. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). Jun 1977. Contract EY-76-C-06-2130. 23p. Dep. NTIS, PC A02/MF A01.

A procedure for determining mercury in liquid samples by cold vapor flameless atomic absorption spectroscopy was developed. The optimum parameter values were determined and mercury standard storage conditions investigated. The effect and tolerance levels of twenty-seven ions, including those ions common to Tank Farm Operations and the Synthetic Wastes, were measured. Standard deviation for the procedure is less than 1%. The procedure can be used to determine mercury at the part per billion level in any liquid sample, a thousand-fold increase in sensitivity over current flame techniques.

35727 (UCID—17756) **NMR method for the determination of NH_4^+ in 1,3,5-triamino-2,4,6-trinitrobenzene (TATB).** Happe, J.A.; Selig, W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Mar 1978. Contract W-7405-ENG-48. 9p. Dep. NTIS, PC A02/MF A01.

A nuclear magnetic resonance (NMR) method has been developed for the determination of the ammonium (NH_4^+) contaminant in 1,3,5-triamino-2,4,6-trinitrobenzene (TATB). The method is simpler than previous methods and eliminates the possibility of extraction errors.

35728 Multicomponent analysis by synchronous luminescence spectrometry. Vo-Dinh, T. (Oak Ridge National Lab., TN). *Anal. Chem.;* **50**: No. 3, 396-401(Mar 1978).

A methodology for the synchronous excitation technique is developed to improve the selectivity of luminescence spectrometry. This approach offers several advantages, including narrowing of spectral bands, an enhancement in selectivity by spectral simplification, and a decrease of measurement time in multicomponent analysis. 7 figures.

35729 Improved sensitivity for boron and silicon in flame spectrometry by a fluoride evolution technique. Chapman, J.F.; Dale, L.S. (Australian Atomic Energy Commission, Lucas Heights, New South Wales). *Anal. Chim. Acta;* **89**: 363-368(1977).

Improved sensitivity can be achieved for boron and silicon by the introduction of their volatile fluorides into chemical combustion flames. The fluorides are produced by reaction with copper hydroxyfluoride. The apparatus consists of a graphite crucible, a resistance furnace and a water jet pump modified to operate with air. The feasibility of this technique for the determination of boron by flame emission, and silicon by atomic absorption, has been demonstrated for solutions and solids.

35730 New portable centrifugal analyzer with expanded versatility. Mrochek, J.E.; Burtis, C.A.; Johnson, W.F.; Bauer, M.L.; Lakomy, D.G.; Genung, R.K.; Scott, C.D. (Oak Ridge National Lab., TN). *Clin. Chem.;* **23**: No. 8, 1416-1426(1977).

New developments in solid-state electronics applied to the Centrifugal Fast Analyzer have resulted in a prototype portable instrument with several unique improvements, yielding expanded analytical versatility and the capability to operate from 110 V ac or a rechargeable battery pack. The analyzer, contained in a 47 x 28 x 30 cm box and weighing 25.4 kg, utilizes a self-contained microprocessor to control some analyzer functions as well as to perform data acquisition and analysis. Hardcopy output is produced by an integral thermal printer. Several analysis options are available, including determination of reaction rate by linear regression analysis. Temperature is controlled at one of three set points (25, 30, or 37°C) by means of a thermoelectric heat pump located in the rotor holder. A clutch-brake assembly incorporated in the rotor-drive system enables the rotor to be accelerated to 80% of run speed within 100 ms. Utilization of a parallel-channel rotor and a high-resolution, 2 MHz clock enables reactions to be monitored within 100 ms of solution transfer. A maximum of 99 observations may be acquired at variable intervals, the minimum being one observation per revolution at 4000

rpm (one observation consists of measurements of dark current and transmission or fluorescence signals from 17 cuvets). The drive system, rotor speed, and the clutch-brake are controlled by the microprocessor and automatically synchronized with data acquisition. Other analyzer operations currently under control of the microprocessor include the selection of preamplifier gain, transmission filters, and primary and secondary filters for fluorescence. The system is described and its various analytical capabilities are evaluated.

SEPARATION PROCEDURES

REFER ALSO TO CITATION(S) 34634, 35720, 35751, 35779

35731 (CONF-770440—, pp 790) **High-temperature strengths of andesite and granodiorite as related to geothermal-energy recovery from magma.** Handin, J.; Friedman, M. (Texas A and M Univ., College Station). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

35732 **Positive pressure columns for solvent cleanup or chromatography.** Semonian, B.P.; Lubkowitz, J.A.; Rogers, L.B. (Univ. of Georgia, Athens). *Anal. Chem.;* **50**: No. 3, 532-533(Mar 1978).

To minimize problems found in classical gravity-feed columns, a closed system was devised in which the high partial pressure of the solvent provided a protective gas blanket. The columns were based on the principle of an addition funnel, and with the aid of a simple mercury pressure valve, the problem of gas bubble formation was eliminated when purifying n-pentane over silica gel. The loss of n-pentane through evaporation was substantially reduced and water contamination was essentially eliminated. The pseudo-sealed system utilized the partial pressure of the n-pentane to generate a pressure of approximately 50 Torr greater than the ambient pressure. The pressure served several functions. It served to collapse any bubbles already present in the column. At the same time, the positive pressure also kept air from leaking around the sides of the stopcock which often generates additional bubbles in the column packing through evaporation. Since the system was a pseudo-closed one, the liquid vaporized to the point of establishing its characteristic partial pressure. After this pressure had been achieved, further losses due to evaporation were eliminated. This system could also be used to exclude atmospheric gases by employing a purge gas.

35733 **Rapid packing of coiled glass gas chromatography columns.** Olerich, G. (Oak Ridge National Lab., TN). *Anal. Chem.;* **50**: No. 3, 543-544(Mar 1978).

The column packer described is a simple, inexpensive device that allows packing the column in the gas chromatographic oven.

35734 (ORNL-tr—4578) **Study of the competition between nitric acid, nitrous acid and the nitrates of uranium(VI) and thorium(IV) in tributyl phosphate extractions.** Marin, B.; Sellier, J.Y.; Gourisse, D. Translated by T.W. Appich, Jr. from *J. Inorg. Nucl. Chem.;* **36**: 1377-1380(1974). 7p. Dep. NTIS, PC A02/MF A01.

The distribution coefficients of U(VI), Th(IV) and Pu(IV) in the system H_2O-HNO_3-HNO_2-TBP-Dodecane can be explained very accurately by simple calculations.

INORGANIC AND PHYSICAL CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 34800, 34801, 35754

35735 (COO—2671-7) **Fundamental studies of metal fluorination reactions. Third annual progress report .** Rapp, R.A.; Reddy, S.N.S.; Chou, S.F.; Lee, B.S. (Ohio State Univ., Columbus (USA). Dept. of Metallurgical Engineering). Jan 1978. Contract EY-76-S-02-2671. 47p.

Results are presented of investigations of the solubility and diffusivity of fluorine in copper. Other research is reported on the electronic conductivity of CaF_2 electrolyte and mixed electrode reactions in solid electrolyte cells. (JRD)

35736 (COO—4185-2) **Ion-exchange of mordenite-type zeolite with Mg^{2+} and La^{3+}.** Smith, J.V. (Chicago Univ., Ill. (USA). Dept. of Geophysical Sciences). 30 Sep 1977. Contract EY-77-S-02-4185. 14p. Dep. NTIS, PC A02/MF A01.

Special techniques were tried for ion-exchanging Mg^{2+} and La^{3+} into mordenite, which is an acid-stable zeolite of possible catalytic value to the coal industry. Electron microprobe analysis showed that ion-exchange occurred only along the main channels of the 100 μm long needles. Complete exchange was not achieved, and exchange was always higher at the ends of the needles. The highest content of Mg^{2+} is 3.7 atoms per unit cell (with 0.2 Na and 1.0 K residual), and the highest content of La^{3+} is 1.7 atoms per unit cell (with 1.7 Na and 0.1 K residual). Higher ion-exchange should be achievable for smaller crystals, such as are commonly made synthetically, but such crystals would be too small for routine X-ray structure analysis. Detailed structural data are given for an Mg^{2+}-exchanged crystal, but interpretation of the cation populations is equivocal. Suggestions are made for further work using (a) X-ray powder techniques and (b) X-ray single-crystal techniques based on a rotating-anode X-ray generator.

35737 (SAND—77-1429C) **Activated gas reactions with silicone and epoxy resins.** DeLollis, N.J. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1978. Contract EY-76-C-04-0789. 8p. (CONF-780502—3). Dep. NTIS, PC A02/MF A01.

From 23. national SAMPE symposium; Anaheim, CA, USA (2 May 1978).

Activated gas plasma technology is widely used for the low temperature ashing of organic materials, for cleaning and etching organic and inorganic materials, and for increasing the surface energy of polymeric materials in preparation for bonding. While some studies have been made of the effect of gas plasmas on natural materials, considerable work remains to be done on the effect of gas plasmas on polymeric resins. This paper reports on the effect of argon and oxygen gas plasmas in terms of weight loss on silicone and epoxy resins. The variables studied are time, pressure and power level. An RTV silicone is very stable in that it shows no weight loss under the test conditions with either oxygen or argon. An epoxy resin has significantly greater weight loss in oxygen compared to argon. When pressure is variable, weight loss peaks out at 0.7 Torr. Weight loss with increase in power level seems to be linear. A rigid aromatic amine cured epoxy tends to be more stable and loses less weight under comparable conditions than does a flexibilized polyamide cured epoxy.

35738 **Dissociation of NF_3 in shock waves.** Breshears, W.D.; Bird, P.F. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Chem. Phys.;* **68**: No. 6, 2996-2997(15 Mar 1978).

The thermal dissociation rate of NF_3 in mixtures of 5% and 10%NF_3 in Ar has been measured behind incident shock waves over the temperature range 1330-2000 K. Dissociation rates were determined from postshock density gradients measured by laser beam deflection. The second order rate coefficient determined for NF_3-Ar collisions is k/sub d/=2.31 x 10^{16} exp(-20500/T) cm^3 mole sec.

35739 **Lability and reactivity of sulfur dioxide-transition metal complexes: crystal and molecular structure of $OsHCl(CO)[P(C_6H_{11})_3]_2(SO_2).2CHCl_3$.** Ryan, R.R.; Kubas, G.J. (Univ. of California, Los Alamos, NM). *Inorg. Chem.;* **17**: No. 3, 637-641(Mar 1978).

An x-ray structure determination of $OsHCl(CO)(PCy_3)_2(SO_2).2CHCl_3$(Cy = cyclohexyl) reveals octahedral coordination about the d^6 osmium(II) and a coplanar Os—SO_2 moiety with the hydride ligand presumably occupying the site trans to the SO_2. The long Os—S bond length (2.239 (3) A) in comparison to those previously found for coplanar M—SO_2 groups is indicative of the strong trans influence of the hydride. The latter is also manifested by the unexpected reversibility of the metal—SO_2 interaction and the reaction of the complex with oxygen in solution to yield an Os(III) sulfato species, $OsCl(CO)(PCy_3)_2(SO_4)$. The structure of the SO_2 adduct shows disorder between the chloride and carbonyl, which has been partially resolved. Important distances and angles are Os—P = 2.421 (3) and 2.425 (3) A, Os—Cl = 2.43 (2) A (average), Os—C = 1.93 (4) A (average), S—O = 1.43 (1) and 1.44 (1) A, O—S—O = 112.9 (6)°, P—Os—S = 102.9 (1) and 100.6 (1)°, and P—Os—P = 156.4 (1)°. Cell data: space group, triclinic; Z = 2; a = 19.501 (9), b = 14.483 (5), c = 10.868 (4) A; α = 70.20 (2), β = 109.86 (2), γ = 120.96 (2)°, R = 0.055 for 4450 diffractometer-collected reflections with I greater than or equal to 3sigma(I). 4 tables, 4 figures.

35740 **Neutron diffraction investigation of the crystal and molecular structure of the anisotropic superconductor Hg_3AsF_6.** Schultz, A.J.; Williams, J.M.; Miro, N.D.; MacDiarmid, A.G.; Heeger, A.J. (Argonne National Lab., IL). *Inorg. Chem.;* **17**: No. 3, 646-649(Mar 1978).

The crystal and molecular structure of Hg_3AsF_6 has been investigated by single-crystal neutron diffraction. This metallic compound crystallizes in the body-centered tetragonal space group $I4_1/amd$ with cell dimensions of a = 7.549 (5) A and c = 12.390 (9) A. The crystal structure consists of two orthogonal and nonintersecting linear chains of Hg/sup 0.33+/ cations passing through a lattice of octahedral AsF_6^- anions. The intrachain Hg—Hg distance of 2.64 (2) A is derived from planes of diffuse scattering normal to a* and b*. Since the a and b axis lattice constants are not simple multiples of the Hg—Hg intrachain distance, the mercury chains are incommensurate with the tetragonal lattice; hence we have the apparent formula $Hg_{2.86}AsF_6$. These results are in essential agreement with a previous-

ly reported x-ray diffraction study. However, from the neutron diffraction data, we have established that the Hg chains are not strictly one-dimensional. The maximum room-temperature deviation from the chain axis is 0.07 (1) A with neighboring chains distorted away from each other. The closest interchain Hg—Hg contact is 3.24 (2) A. Furthermore, analytical data consistently indicate a stoichiometric empirical formula of Hg_3AsF_6. These results together with precise density measurements imply that the incommensurate structure is stabilized by anion vacancies, such that there are four formula weights of $Hg_{2.86}(AsF_6)_{0.953}$ per unit cell. 4 tables, 2 figures.

35741 Thermodynamics of electrolytes. IX. Rare earth chlorides, nitrates, and perchlorates. Pitzer, K.S.; Peterson, J.R.; Silvester, L.F. (Lawrence Berkeley Lab., CA). *J. Solution Chem.;* **7**: No. 1, 45-56(Jan 1978).

The extensive data for the osmotic coefficients, heats of dilution, and densities of aqueous solutions of rare earth chlorides, nitrates, and perchlorates are fitted to a single type of equation found satisfactory for many other solutes. Good agreement is obtained. The various parameters do not show simple trends with cation radius. While there are some plausible explanations of these complexities, the total picture is far from clear.

35742 Anodic behavior of lithium in aqueous lithium hydroxide solutions. Cooper, J.F.; Hosmer, P.K.; Homsy, R.V. (Univ. of California, Livermore). *J. Electrochem. Soc.;* **125**: No. 1, 1-7(Jan 1978).

The anodic behavior of lithium in 3M to 5M LiOH was investigated at ambient temperatures under well-defined hydrodynamic conditions by use of a flow channel. The electrode showed a linear polarization behavior up to a mass-transfer-limited anodic current density. The rate of the parallel chemical corrosion of lithium was determined over a range of current densities, flow rates, and concentrations by use of a gas coulometer to measure the total rate of hydrogen evolution. The corrosion rate approaches zero linearly as the current density approaches the diffusion-limited level. On the basis of electrode resistance and efficiency, the plane-parallel electrode configuration was judged suitable for batteries of the lithium-water type. 13 figures, 3 tables.

35743 Inconsistencies in a criticism of the Flood—Grjotheim treatment of slag equilibria. Blander, M. (Argonne National Lab., IL). *Metall. Trans., B;* **8B**: 529-530(Dec 1977).

A criticism of the Flood—Grjotheim ionic treatment by Elliott et al. is reexamined in the light of well-established theories of reciprocal systems. The criticism is shown to be unjustified and the equations derived by Elliott et al. appear to be a restatement of the Flood—Grjotheim equation.

35744 Dodecatungstophosphoric acid hexahydrate, $(H_5O_2^+)_3(PW_{12}O_{40}^{3-})$. The true structure of Keggin's 'pentahydrate' from single-crystal x-ray and neutron diffraction data. Brown, G.M.; Noe-Spirlet, M.R.; Busing, W.R.; Levy, H.A. (Oak Ridge National Lab., TN). *Acta Crystallogr., Sect. B;* **33**: 1038-1046(1977).

The structure of Keggin's [Proc. Roy. Soc. (1934), A144, 75-100] dodecatungstophosphoric acid "pentahydrate" was redetermined with extensive x-ray and neutron diffraction data from single crystals. The "pentahydrate" is really the hexahydrate of formula $(H_5O_2^+)_3(PW_{12}O_{40}^{3-})$. The six water molecules are paired in nearly planar diaquahydrogen ions $H_5O_2^+$ (symmetry 222), which have linear centred O...H...O bonds only 2.370 (5) A long (2.414 A corrected for thermal motion), each such ion being in twofold disorder on a 42m site. The H_2O valence angle is 118.7 (5)°. An alternative interpretation consistent with the thermal parameters is that the H_2O...H of each end of the $H_5O_2^+$ ion has the geometry of a rather flat pyramid and that additional disorder of the O atoms about the twofold axis on which they appear to lie produces apparent 222 symmetry for the $H_5O_2^+$ ion. The structure of the anion $PW_{12}O_{40}^{3-}$ (43m symmetry) is essentially that of Keggin, though the O atoms are shifted 0.17 to 0.25 A from the positions Keggin gave. The structure will readily accommodate the extra acidic H atoms of the isomorphous hexahydrates (so-called "pentahydrates") of silico-, boro- and metadodecatungstic acids. It is inferred that the various structurally similar salts of univalent cations with 12-heteropoly anions, such as $Cs_3(PW_{12}O_{40})$, in which the cations are at the 42m sites replacing $H_5O_2^+$ ions, are all properly to be formulated as anhydrous salts. Crystal data: cubic Pn3m, a = 12.506 (5) A [23.5 +- 1 °C, lambda(Mo $K\alpha_1$) = 0.70926 Al, Z = 2, d/sub c/ = 5.53, d_0 = 5.60 g cm^{-3} (Keggin, 1934), V/sub cell/ = 1793.9 A^3, formula weight 2989.1.

35745 Cyanide bonding on AG (110) investigated by electroreflectance. Furtak, T.E. (Ames Lab., IA). *Solid State Commun.;* **23**: 373-376(1977).

Electric field modulation of the normal-incidence optical reflectivity (from 3.1 to 4.3 eV) of (110) silver with cyanide bonded to the surface is described. The spectra show an enhancement in anisotropy with respect to the orientation of the light polarization. It is suggested that this effect, together with the shift of structure to higher photon energy with increasing cyanide coverage, can be explained by CN^- (sigma) → Ag(ap) bonding with over-compensating Ag(d) → CN^- (π^*) back donation. Other interpretations are disclosed and future applications of silver-electrolyte electroreflectance to help understand cyanide bonding are proposed.

35746 Thermal decomposition of grain dust: an early warning for incipient fire or explosion. Gibson, E.D.; Morris, V.; Chiotti, P. *Trans. ASAE (Am. Soc. Agric. Eng.);* **20**: No. 2, 380-385(1977).

Tests were conducted to evaluate the response of ionization type detectors and combustible gas detectors to invisible aerosols and gases evolved from heated grain dust at temperatures below the ignition temperature. The concentration of aerosol particles as a function of temperature and dust layer thickness was determined. The aerosol concentration from a heated surface is sensitive to dust layer thickness and at a given temperature and heating rate, it decreases quite rapidly for thicknesses greater than 0.03 cm. Thin dust layers heated at 24 °C/min triggered a Pyr-A-Larm detector unit (set to respond at (2-3) x 10^5 particles/cm^3) when the dust reached a temperature of 200 °C, and at 225 °C when the aerosol was drawn through a fiberglass filter. A combustible gas detector could be set to respond at temperatures well below the ignition temperature and did not appear to be sensitive to dust layer thickness of up to 0.64 cm. The potential application of such detectors in an early warning system to detect hot spots approaching dust ignition temperatures in a grain elevator or feed mill environment is discussed.

35747 Ultraviolet absorption studies of the alkali metal atom-oxygen molecule matrix reaction. Andrews, L. (Univ. of California, Berkeley). *J. Mol. Spectrosc.;* **61**: 337-345(1976).

Alkali metal atoms were codeposited with oxygen at high dilution in argon on a sapphire window cooled to 17K. Ultraviolet spectra contained a medium intensity absorption near 250 nm which exhibited a long wavelength component between 269 and 275 nm for the heavier alkali metals. The 250 nm band arises from $M^+O_2^-$ and is assigned to a $\pi \rightarrow \pi^*$ superoxide transition, and the absorption near 270 nm, which increased on sample warming, is attributed to $M^+O_4^-$.

35748 Accuracy of kinetic parameters estimated from batch and integral reactor data. Ravimohan, A.L.; Chen, W.H.; Seinfeld, J.H. (California Inst. of Tech., Pasadena). *Can. J. Chem. Eng.;* **48**: 420-427(Aug 1970).

The accuracy of rate constant estimates obtained by minimizing the sum of squares of differences between observed and calculated concentrations is considered. Closed solutions are obtained for some basic types of first order reaction schemes. The results are presented in the form of plots of the dimensionless variance of parameter estimates. The kineticist can use the plots both in analyzing experiments and in planning them for maximum economy. Such advance studies are capable of providing valuable insight into questions of experimental design even when the reaction scheme is unknown. 10 figs.

35749 (LA-tr—78-27) **Equilibrium of the reduction of cuprous bromide and the electrochemical properties of copper.** Kapustinskii, A.; Panteleev, B. Translated from *Zh. Fiz. Khim.;* No. 18, 32-42(1944). 17p. Dep. NTIS, PC A02/MF A01.

Studies on the effects of hydrogen on the following reversible reaction of liquid cuprous bromide, $2CuBr(l) + H_2(g) \rightarrow 2Cu(s) + 2HBr(g)$, in the 485 to 655°C temperature range were performed by Jellinek and Uloth and then by Jellinek and Rudat at higher temperatures. In spite of the fact that the same method was used in order to study the equilibrium system, i.e., the dynamic method, the results obtained by these authors are not in agreement and have not been thermodynamically analyzed. In studies by Klein, Jahn-Held and Jellinek, and Ishikawa, Jamazaki and Murooka, attempts were made to evaluate the thermodynamic constants of cuprous bromide by studying the corresponding galvanic circuits. In this case, however, the calculations are complicated by the uncertainty of the correction which must be introduced in considering the difference in potentials between the copper and its amalgam. Thus we still do not clearly understand the thermal behavior of copper bromide and therefore cannot obtain matching thermal and electrochemical measurements. In addition, as will be seen, this study is not only of interest for its own sake but it also permits us to approach problems related to the electrochemical and thermal properties of metallic copper. This gave us the incentive to study thermal equilibria in the reduction of cuprous bromide in the development of a study of cuprous chloride performed earlier by one of us using the static method. As a basis for this study we also used the static method.

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

REFER ALSO TO CITATION(S) 34594

35750 Mechanisms of hydrothermal crystallization of quartz of 250°C and 15 kbar. Matsuhisa, Y.; Goldsmith, J.R.; Clayton, R.N.

(Univ. of Chicago). *Geochim. Cosmochim. Acta;* **42**: No. 2, 173-182(Feb 1978).

Oxygen isotopic exchange between quartz and water, using a novel technique in which both $^{18}O/^{16}O$ and $^{17}O/^{16}O$ fractionations were measured, yielded an equilibrium fractionation $\Delta^{18} = 9.0$ at 250°C and 15 kbar. The reaction proceeds predominantly by solution of fine grains and growth of larger grains. Exchange by solid-state diffusion is immeasurably slow at this temperature. Under the same experimental conditions, cristobalite behaves quite differently, becoming transformed to sub-micron quartz crystals in a few minutes. The phase transformation is accompanied by a kinetic isotope effect yielding quartz in isotopic disequilibrium with water. It is possible that such disequilibrium products are also formed in other experiments involving phase transitions or mineral syntheses.

35751 Kinetics of a square cascade of close-separation stages under total reflux. Wieck, H.; Ishida, T. (City Univ. of New York, Brooklyn). *Sep. Sci.;* **12**: No. 6, 587-605(1977).

To facilitate the determination of the separation factor and the number of theoretical stages of a square cascade of close-separation stages from measurements of its long-time kinetics under total reflux, extensive tables of kinetics parameters have been produced in accordance with K. Cohen's theory. Cohen's treatment has been extended in several ways. The kinetics parameters of the first transient term have been finely mapped, and the ranges of various parameters have been extended to include large overall separations as well as the stripping section. The second transient term of the long-time kinetics has been evaluated, and a possible application of this correction term has been suggested in relation to the experimental determination of the column parameters. Under comparable conditions a steady concentration profile, along the column, is attained faster in the stripping section than in the enriching section. A distinction between the enriching and stripping section is important in using transient theory for the evaluation of the cascade characteristics under ordinary laboratory conditions.

ORGANIC CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

REFER ALSO TO CITATION(S) 35923, 36042

35752 (COO—4446-1) **Solid phase catalysts and reagents. Progress report, July 1, 1977—June 30, 1977.** Regen, S.L. (Marquette Univ., Milwaukee, Wis. (USA)). Feb 1978. Contract EG-77-S-02-4446. 8p. Dep. NTIS, PC A02/MF A01.

Research supported under this contract has involved four major areas relating to the study and development of the triphase catalytic method: (1) preparation and characterization of 21 new polymer resins that have potential use as triphase catalysts, (2) testing of these polymers in standard synthetic reactions, (3) kinetic and mechanistic studies for the triphase catalyzed displacement by cyanide ion on benzyl chloride using an ion-exchange resin and (4) development of solid/liquid/solid--triphase catalytic procedures based on polystyrene-bound hexamethylphosphoramide copolymers.

35753 (LBL—6934) **Active sites for hydrocarbon catalysis on metal surfaces.** Somorjai, G.A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 18 Oct 1977. Contract W-7405-ENG-48. 14p. (CONF-770950—2). Dep. NTIS, PC A02/MF A01.

From 26. meeting of the international union of pure and applied chemistry; Tokyo, Japan (4 Sep 1977).

There is a great deal of experimental evidence associating selective bond breaking ability with low coordination number surface sites on transition metal surfaces. Atomic steps break H-H and C-H bonds efficiently while kinks in the steps are required for additional C-C and C=O bond scissions. The blockage of some of the "active sites" yields the reaction selectivity commonly observed as a result of alloying or upon introduction of certain promoters. Another important parameter in controlling transition metal catalytic activity is the formal oxidation state of the surface metal atom. Oxidation of the surface atoms by oxygen or halogens or their reduction by electron donors (carbon, alkali metals, etc.) changes markedly the catalytic surface chemistry. H_2-D_2 exchange, hydrocarbon conversion reactions and the hydrogenation of CO are examples to demonstrate the importance of low coordination number sites and surface oxidation state in controlling catalytic activity and selectivity.

35754 Decarbonylation of 2-germaacetic acid in aqueous solutions. Yang, D.J.; Jolly, W.L. (Univ. of California, Berkeley). *Inorg. Chem.;* **17**: No. 3, 621-624(Mar 1978).

In dilute aqueous acid solutions (0.05 to 0.5 M H^+), 2-germaacetic acid decomposes to form carbon monoxide, an orange-yellow solid of approximate composition $GeH_{0.6}$, and small amounts of germane. The rate law for the reaction is $-d[GeH_3COOH]/dt = k[H^+][GeH_3COOH]$; $k = (5.59 +- 0.14) \times 10^{-4} M^{-1}s^{-1}$ at 22.5°C and ionic strength 1.0 M. From rate measurements in the temperature interval 0 to 39.5°C, the activation energy was determined to be 16.9 kcal/mol. When the reaction is carried out in strongly acidic solutions (e.g., greater than 6 M HCl, greater than 4 M H_2SO_4, or greater than 6 M $HClO_4$), carbon monoxide is evolved quantitatively, but no solid hydride or germane forms. The resulting solution contains the GeH_3^+ group, probably stabilized in the form of the germyloxonium ion, $GeH_3OH_2^+$. The data implicate GeH_2 as an intermediate of the reaction in dilute acid solutions. 2 figures, 2 tables.

35755 Graph theoretical approach to conjugation and resonance energies of hydrocarbons. Randic, M. (Iowa State Univ., Ames). *Tetrahedron;* **33**: 1905-1920(1977).

Kekule forms of conjugated hydrocarbons are examined and an alternative description based on a set of circuits with a formal alternation of single and double bonds rather than traditional set of Kekule structures offered. The approach is graph theoretical and the analysis consists in enumeration of these unique circuits (called conjugated circuits) and subsequent parametrization when molecular properties are discussed. The concept of conjugated circuits appears close to chemical ideas and was found to directly lead to expressions for resonance energies. While in benzenoid hydrocarbons only circuits of $(4n + 2)$ size arise in cyclobutadienes also conjugated circuits of 4n type arise indicating the origin for a lesser stability of these molecules. In polycyclic non-alternant systems some compounds have only conjugated circuits of $(4n + 2)$ size, and distantly resemble benzenoids. Others have conjugated circuits of $(4n + 2)$ and 4n kind and should subsequently be expected to show a greater dissimilarity with benzenoid systems. Resonance energies of both classes of compounds are examined and the decomposition of the conjugation into circuits of different size is used as the basis for an independent estimate of resonance energies, of the quality of SCF MO calculations. An impressive agreement of the simple graph theoretical approach and fairly elaborate iterative calculations is found, which in the majority of cases is within only few hundredths of an eV. In contrast to usual empirical curve-fitting procedures the parameters involved have simple structural significance. Similarities and differences (of a conceptual nature) of the graph approach and the approach of Hendron are discussed. Combinatorial basis of the graph theoretical scheme however offer additional interesting connections between properties, such as resonance energies, of different molecules.

35756 Polariton effects in naphthalene crystals. Robinette, S.L. Iowa City; Iowa State Univ. (1977). 193p. University Microfilms Order No. 77-29,865.

Thesis (Ph. D.).

The existence of a mixed state of the polarization field and the photon field has come to be known as a polariton. In the polariton picture, a photon enters the crystal and forms a mixed state having both polarization field and photon character. In the idealization of an infinite perfectly ordered crystal, energy, initially carried, by the photon is "stored" in the crystal. Absorption results when this polariton wave is damped, or equivalently when the polariton quasi-particle is scattered by a phonon, chemical impurity, or lattice defect. Absorption seen in this way is defined as an irreversible loss of photon energy to the lattice (heat bath) rather than the creation of a polarization state in the crystal. The experimental verification of the two-step nature of energy dissipation is the subject of this dissertation. The a(0,0) Davydov component of the lowest energy singlet transition in pure strain-free naphthalene single crystals is shown to exhibit an increase in absorption with increasing temperature. This is due to an increase in polariton damping via polariton-phonon scattering processes. Another prediction of the polariton model is that the coupling between polarization states and photons is proportional to the oscillator strength of the crystal transition. This dependence implies that transmission and reflection spectra for large oscillator strength transitions ($f \geqq 0.1$) may be very different from the true absorption (defined by $A = 1\text{-}R\text{-}T$).

35757 Autoxidation of fatty acid monolayers adsorbed on silica gel. 1. Nature of adsorption sites. Wu, G.S.; Mead, J.F. (Univ. of California, Los Angeles). *Lipids;* **12**: No. 11, 965-970(1977).

An unsaturated fatty acid monolayer deposited on a silica gel surface has been chosen as a model for studying nonenzymatic autoxidation of membrane lipids. Studies to determine the suitability of this system as a model for biomembranes were conducted to define the nature of the monolayers, particularly with respect to the factors determining the concentration of the fatty acid molecule on unit area of the surface. The results from adsorption isotherm, high temperature dehydroxylation, and infrared spectra studies show that adsorption of a monomolecular layer of fatty acids occurs and that the number of molecules absorbed corresponds to the number of isolated, non-hydrogen-bonded silanol groups. It is presumed the binding is by hydrogen bonding of the carboxyl groups to silanol groups. The packing density of the fatty acid molecules is 1.25 molecule/100 A^2 which is similar to the density of the isolated silanol sites on the surface.

35758 Non-uniform breakage-mechanism branching processes and degradation of long-chain polymers. Olson, W.H. (Oak Ridge National Lab., TN). *J. Appl. Probab.;* **14**: 1-13(1977).

The problem of number and weight distributions for breakage-mechanism branching processes whose break distributions are general is considered. A recursive relation between the expected empirical distribution after (n + 1) breaks and after n breaks, making use of length-biased sampling is derived. Using this relation and the strong law of large numbers, integro-differential equations are derived for the asymptotic expected empirical distribution and its associated weight distribution. The mean of the asymptotic number distribution is derived using the integro-differential equation. Approximate solutions to these equations and the moments of these approximations are then provided. Finally these results are applied to the case where the break distribution is a symmetric beta distribution.

35759 Crystal and molecular structure of carbamate insecticides. II. Aldicarb. Takusagawa, F.; Jacobson, R.A. (Ames Lab., IA). *J. Agric. Food Chem.;* **25**: No. 2, 333-336(1977).

The crystal and molecular structure of aldicarb (2-methyl-2-(methylthio) propionaldehyde O-(methylcarbamoyl) oxime, $C_7H_{14}N_2O_2S$) has ben determined by single-crystal x-ray diffraction techniques. It crystallizes in an orthorhombic unit cell, Pcab, with unit cell dimensions a = 10.204 (7), b = 21.155 (9), and c = 10.003 (7) A and eight molecules per cell. The structure was refined to a final crystallographic discrepancy factor of 9.3% for 532 observed reflections (absolute value $F_o > 3\sigma$/sub F0/). Large thermal parameters resulted from the refinement due to the close proximity to a phase transition (at 13 +- 3°C). The low-temperature phase was found to be monoclinic, $P2_1/a$, with a = 10.25, b = 20.99, and c = 10.07 A and β = 91.97°. The C-O single bond distance in the carbamate group was found to be significantly lengthened (1.414 A) relative to equivalent distances found in carboxylic acid esters. Such a lengthening would correlate well with any theory involving disruption of this bond in a reaction of this molecule with acetylcholinesterase enzyme.

35760 N-alkylation of aromatic amines with tris(trifluoroethyl)phosphate. Bissell, E.R. (Univ. of California, Livermore). *J. Fluorine Chem.;* **9**: 5-13(1977).

Results of a study of the use of tris (trifluorethyl) phosphate for the alkylation of aromatic amines are reported. Tris (trifluoroethyl) phosphate is a satisfactory reagent for introducing a trifluoroethyl group into aromatic amines, except for those containing N-alkyl, hydroxyl, or alkoxyl substituents and for those containing strongly electron-withdrawing groups such as nitro and carboxyl.

35761 Electron impact investigation of pentafluoroethyl iodide. Hsieh, T.; Hanrahan, R.J. (Univ. of Florida, Gainesville). *Int. J. Mass Spectrom. Ion Phys.;* **23**: 201-207(1977).

An electron impact investigation on C_2F_5I was made using the Retarding Potential Difference technique in a Bendix time-of-flight mass spectrometer. Appearance potentials were measured as follows: CF_3^+, 13.73 eV; $C_2F_5^+$, 11.71 eV; and $C_2F_5I^+$, 10.66 eV. From these results and previously published values it is possible to derive $\Delta H°$/sub f/(C_2F_5I) greater than or = to -236.4 kcal mol^{-1}; $\Delta H°$/sub f/($C_2F_5I^+$) less than or = to +9.4 kcal mol^{-1}, and D(C_2F_5-I) less than or = to 47.0 kcal mol^{-1}. Observation of certain reaction channels in a parallel Ion Cyclotron Double Resonance experiment suggests that $\Delta H°$/sub f/($C_2F_4I^+$) = +82.0 +- 2 kcal mol^{-1}. From the latter result it is also possible to derive that D(F-$C_2F_4I^+$) = 91.5 kcal mol^{-1}. In principle, D(CF_3-CF_2I) could also be established if $\Delta H°$/sub f/(CF_2I) were known. If D(F-CF_2I) is estimated as 120 kcal mol^{-1}, then $\Delta H°$/sub f/(CF_2I) = -40 kcal mol^{-1}, and D(CF_3-CF_2I) approximately = to 79 kcal mol^{-1}. Uncertainties of +-0.1 eV are assigned to appearance potentials and +-2 kcal mol^{-1} to heats of formation.

35762 Structure and stereochemistry of α- and β-cubebene from the crystal structure of norcubebanone, $C_{14}H_{22}O$. Thiessen, W.E. (Oak Ridge National Lab., TN). *Acta Crystallogr., Sect. B;* **33**: 3838-3842(1977).

The crystal structure of norcubebanone, $C_{14}H_{22}O$, a conjugated cyclopropyl ketone, has been solved by direct phase determining methods. The ketone crystallizes in the orthorhombic system with a = 8.480 (2), b = 23.502 (5), c = 6.314 (1) A, space group $P2_12_12_1$, with four molecules in the unit cell. The structure was refined by full-matrix least-squares methods to a final R(F) = 0.044 on 1494 reflections whose intensities were measured to be greater than their estimated standard deviations on a Picker automatic diffractometer with Cu Ka radiation. The observed molecular structure. 7(S)-isopropyl-10(R)-methyl-5 R,6R)-tricyclo[4.4.0.0^{1,5}]decan-4-one, establishes the structures of the natural products from which it was derived and provides a precise molecular geometry of the conjugated system.

35763 Surface deterioration of ammonium acid phthalate crystals. Barrus, D.M.; Blake, R.L.; Burek, A.J. (Los Alamos Scientific Lab., NM). *X-Ray Spectrom.;* **5**: 92(1976).

In working with various acid phthalate crystals for low energy X-ray spectroscopy, we have observed a relatively rapid surface degradation of ammonium acid phthalate in comparison with similar crystals was observed. It was found that two different samples degraded in a few days upon exposure to high vacuum (10^{-6} - 10^{-7} torr). The same crystals showed similar effects when exposed to room atmosphere for two to three weeks. One of these crystals deteriorated while kept constantly in a desiccator jar for about two years. The desiccator environment seems to be the most favorable. The observed difference in the surface of these crystals might be described as a change from a transparent, glasslike condition to a white, powderlike haze somewhat akin to frosted glass. A two week exposure to vacuum for a freshly cleaved crystal caused the integrated coefficient of reflection at 23.6 A to decrease by a factor of 2.5. The degraded surface areas tend to form definite rhombohedral patterns. Since the external symmetry of ammonium acid phthalate crystals is rhombohedral, this suggests that the degradation we observe takes place in the form of large etched figures. A possible mechanism may be sublimation, which would proceed more rapidly in vacuum than in air. It is concluded that ammonium acid phthalate should be kept in a desiccator environment as much as possible. Exposures to vacuum should be brief and critical diffraction measurements should be done using a freshly cleaved surface.

35764 (LA-tr—78-16) **Carbon-13, nitrogen-14, oxygen-17 NMR (nuclear magnetic resonance) spectra of aromatic nitro-compounds.** Magi, M. Translated by V.M. Manca from *Izv. Akad. Nauk Est. SSR, Khim. Geol.;* **20**: No. 4, 364-366(1971). 8p. Dep. NTIS, PC A02/MF A01.

^{13}C, ^{14}N, and ^{17}O NMR spectra of a series of nitrobenzenes, nitrophenols, and nitroanilines were measured. Measurement precision of the chemical shifts was +-0.2 m.d. in ^{13}C and +-0.5 m.d. in ^{14}N. (LK)

ISOTOPE EFFECTS

35765 Carbon-13 vapor pressure isotope effect in CHF_3. Borodinsky, L.; Wieck, H.J.; Mayfield, D.; Ishida, T. (Department of Chemistry, The City University of New York, Brooklyn College, Brooklyn, New York 11210). *J. Chem. Phys.;* **68**: No. 7, 3279-3285(1 Apr 1978).

The vapor pressure difference between $^{12}CHF_3$ and $^{13}CHF_3$ has been measured by means of a cryogenic distillation under total reflux at 11 temperatures between 161.2 and 204.6 °K. A second-order extension of Cohen's column kinetics has been tested. The reduced partition function ratio obtained from the distillation data has led to a plot of T ln(f/sub c//f/sub g/) vs 1/T, which displays a steep negative slope and points to a crossover at a temperature above those of the present experiment. The steep negative slope is due to strong external—internal interactions in liquid fluoroform, and the predicted crossover is a consequence of a blue shift in the C—H stretching frequency upon condensation of fluoroform.

ELECTROCHEMISTRY

REFER ALSO TO CITATION(S) 35333, 35639, 35718, 35735

35766 (LBL—6016, pp 425-430) **Conservation.** Muller, R.H.; Neuman, J.; Tobias, C.W. 1976.

In Materials and Molecular Research Division annual report, 1976.

Research in the field of electrochemical reactions was carried out in the following areas: electrowinning or refining of potassium metal; properties and modes of formation of anodic surface layers on materials of interest for battery applications (Zn, Ag, Cd, Pb, Cu, Li); surface morphology of metals in electrodeposition; and analysis and simulation of electrochemical systems (packed beds, flow-through porous electrodes). 4 figures. (RWR)

35767 Surface variations of hydrogen chemical potential during hydrogen charging of metals by electrolysis. Lewis, F.A. (Queen's Univ., Belfast). pp 5p, Paper 5A2 of Hydrogen in metals. Vol. 9. Elmsford, NY; Pergamon Press Inc. (1977).

From 2. international congress on hydrogen in metals; Paris, France (Jun 1977).

See CONF-770613—P9.

Studies with electrodes of palladium and palladium alloys directed attention to problems concerning preferred sites for electrolytic hydrogen discharge, variations of surface hydrogen chemical potential, and local cell hydrogen transfer effects.

PHOTOCHEMISTRY

REFER ALSO TO CITATION(S) 35768, 35769

RADIATION CHEMISTRY

35768 (COO—2086-88) **Radiolysis studies on reactive intermediates.** Kevan, L. (Wayne State Univ., Detroit, Mich. (USA). Dept. of Chemistry). Nov 1977. Contract EY-76-S-02-2086. 27p. Dep. NTIS, PC A03/MF A01.

A more quantitative characterization of the structure and reaction mechanism of solvated electrons produced by high energy chemistry was developed. Neutral atoms may undergo solvation in polar media to cause significant geometrical rearrangement. The geometrical arrangement of six OH bond oriented water molecules around a localized electron is the preferred geometry in frozen aqueous systems even at low solute ion concentration. The energy level structure of electrons in polar aqueous and alcoholic glasses was systematized from a comparison of photoconductivity and optical spectra. Experimental and theoretical evidence on electron solvation was evaluated to suggest the dominance of first solvation shell orientation in the solvation process. A laser photolysis study as a function of temperature suggests that electron solvation in ethanol glass occurs by a hindered molecular reorientation mechanism. In mixed polar and nonpolar glassy matrices it was shown that the electron is first solvated in the nonpolar matrix and is later transformed to a more stable species surrounded by the polar molecules. It was found that the spin lattice relaxation of solvated electrons is dominated by a new mechanism characteristic of disordered matrices which involves relaxation by tunneling modes in the matrix. The noninteracting spin packet model of electron spin resonance lines was shown to apply to solvated electrons in deuterated matrices but not in protiated matrices. A new type of recombination fluorescence experiment was devised which allows easy distinction between tunnelling and diffusive recombination mechanisms between solvate electrons and cations. Several theoretical studies have helped to delimit the applicability of an electron tunneling mechanism to solvated electron reactions. Electron spin echospectrometry was used to demonstrate that silver atoms undergo dramatic solvation and desolvation changes in frozen aqueous systems.

35769 (COO—3009-28) **Action of radiations on some biological model systems.** Czapski, G. (Hebrew Univ., Jerusalem (Israel). Dept. of Physical Chemistry). Jun 1977. Contract EY-76-C-02-3009. 7p. Dep. NTIS, PC A02/MF A01.

Brief summaries are presented of studies on primary photochemical processes under conditions of high excitation intensity of pulsed lasers and pulse radiolysis studies of inactivation of ribonuclease by redox reactions and the redox mechanism of cytochrome C. Publications resulting from these studies are cited. (JSR)

35770 **Radiation damage studies by x-ray photoelectron spectroscopy. I. Electron irradiated $LiNO_3$ and Li_2SO_4.** Sasaki, T.; Williams, R.S.; Wong, J.S.; Shirley, D.A. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory). *J. Chem. Phys.;* **68**: No. 6, 2718-2724(15 Mar 1978).

X-ray photoelectron spectroscopy (XPS) was applied to the study of radiation damage on the surfaces of $LiNO_3$ and Li_2SO_4 single crystals which were free of carbon contamination. Irradiations were done in situ at room temperature with 0.3-1.6 keV electrons. The products, assigned from chemical shifts in the binding energies of core levels, were: $LiNO_2$ and Li_2O from irradiated $LiNO_3$ and Li_2SO_3, elemental sulfur, Li_2S, Li_2O, and adsorbed oxygen species from irradiated Li_2SO_4, respectively. There was no indication in either sample of the metallic lithium formation reported previously. Heavy irradiations of the Li_2SO_4 sample showed that the final products of the radiation decomposition are Li_2O and Li_2S. The G values (the number of molecules produced or decomposed per 100 eV of radiation absorbed) of the radiation decomposition and product formation for 1.4 keV incident electrons were estimated from differential energy loss to be approximately 10^{-3}-10^{-4}.

35771 **Self-luminescence of several fluorite-structure halides doped with curium or berkelium.** Finch, C.B.; Fellows, R.L.; Young, J.P. (Oak Ridge National Lab., TN). *J. Lumin.;* **16**: No. 1, 109-115(Jan 1978).

The self-luminescence emission spectra of several fluorite-structure halides doped with 0.1 cation % ^{244}Cm or ^{249}Bk were measured in the range 14 x 10^5 to 50 x 10^5 m^{-1} (200-700 nm) between 295 and 600°K. The hosts studied included CaF_2, SrF_2, BaF_2, and $SrCl_2$ (for Cm) and BaF_2 and $SrCl_2$ (for Bk). The room-temperature spectra of the Cm-doped samples all have relatively sharp peaks at approximately 16.5 x 10^5 m^{-1} and broad, asymmetric bands with maxima near 35 x 10^5 m^{-1} (fluorides) or 28 x 10^5 m^{-1} ($SrCl_2$). The sharp peaks are attributed to the Cm dopant and are stable to at least 600°K, while the broad bands appear to be associated with host anion centers and disappear on sample heating. The room-temperature spectrum of Bk-doped BaF_2 also displays an anion-related band at 35 x 10^5 m^{-1}, while that of Bk-doped $SrCl_2$ has both an anion band at 28 x 10^5 m^{-1} and a peak at 19 x 10^5 m^{-1} (believed to be an additional host effect). The luminescence intensity of all samples decreased with room-temperature storage, but could be partially restored by annealing.

RADIOCHEMISTRY AND NUCLEAR CHEMISTRY

35772 **Synthesis of 25-hydroxy[23,24-^{3}H]vitamin D_3.** Yamada, S.; Schnoes, H.K.; DeLuca, H.F. (Univ. of Wisconsin, Madison). *Anal. Biochem.;* **85**: No. 1, 34-41(Mar 1978).

A synthesis of 25-hydroxy[23,24-^{3}H]vitamin D_3 leading to a radiochemically pure product with a specific activity of 78 Ci/mmol is described. The structure of the product was confirmed by comparison with unlabeled material and its biological activity was established by in vitro conversion to 1α,25-dihydroxy[23,24-^{3}H]vitamin D_3 using the chick kidney 1α-hydroxylase system.

PROPERTIES OF RADIOACTIVE MATERIALS

REFER ALSO TO CITATION(S) 34579

35773 (Juel—1366) **Annual report 1975 of the Department Decontamination.** Anger, W.; Zange, E. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Abt. Dekontamination). Dec 1976. 69p. (In German). Dep. NTIS (US Sales Only), PC A04/MF A01.

This annual report presents a survey of the activities in the field of 'decontamination operations', including de-radiation techniques and nuclear waste techniques, of activities in the field of 'laboratories and the water complex', including waste water operations and laboratory group, and of publications and patents of the Decontamination Department of the KFA.

35774 (LBL—6016, pp 387-410) **Low energy nuclear science.** 1976.

In Materials and Molecular Research Division annual report, 1976.

The status of the following projects is reported: highly selective sequestering agents for plutonium and other actinides in the 4+ oxidation state; synthetic and structural studies of actinide and other compounds; solution processes and electronic spectra for uranium(III) and uranium(IV) in anhydrous hydrogen fluoride; optical studies of U^{4+} in $ThBr_4$; free ion studies of the actinides; and spectral properties of $(Et_4N)_2UI_6$ and $(Et_4N)_2UF_6$. (LK)

35775 **Preparation and molecular and crystal structures of uranium(IV) borohydride-dimethyl ether and uranium(IV) borohydride-diethyl ether.** Rietz, R.R.; Zalkin, A.; Templeton, D.H.; Edelstein, N.M.; Templeton, L.K. (Univ. of California, Berkeley). *Inorg. Chem.;* **17**: No. 3, 653-658(Mar 1978).

Uranium(IV) borohydride reacts with dimethyl ether and diethyl ether to form $U(BH_4)_4.O(CH_3)_2$ and $U(BH_4)_4.O(C_2H_5)_2$, respectively. The yields are greater than 90 percent. The latter compound can also be prepared by reacting UF_4 and $LiBH_4$ in diethyl ether for 1 week. Both compounds are green, crystalline solids that can be sublimed in bulk at 50°C and 10^{-5} mm. Single-crystal x-ray diffractometry has shown both of these materials to be monether complexes in the solid state. $U(BH_4)_4.O(CH_3)_2$ is orthorhombic, Pnma, with a = 11.423 (5) A, b = 10.120 (4) A, c = 9.915 (4) A, and Z = 4. $U(BH_4)_4.O(C_2H_5)_2$ is monoclinic, $P2_1$, with a = 7.95 (1) A, b = 15.24 (1) A, c = 5.74 (1) A, β = 106.0 (1)°, and Z = 2. The structure of each complex consists of infinite linear chains of alternating uranium and boron atoms joined by double-hydrogen-bridge bonds. The remaining borohydrides are attached to the uranium atom by triple-hydrogen-bridge bonds. The ether moieties are associated to the uranium by the oxygen atoms. In the dimethyl ether adduct successive ether molecules along the chain are trans, whereas in the diethyl ether compound they are all cis. The total coordination about the uranium atom is 14, i.e., 1 oxygen atom and 13 hydrogen atoms. The average U—B distances for the triple-bridge and double-bridge bonds are 2.53 (2) and 2.89 (1) A, respectively. The average U—O bond length is 2.46 (3) A. A refinement of the anomalous dispersion term f'' for uranium in the ethyl compound shows that the crystal was twinned, containing unequal fractions of the enantiomeric configurations. 5 tables, 4 figures.

35776 **Preparation and crystal structure of uranium(IV) borohydride-bis(tetrahydrofuran), $U(BH_4)_4.2OC_4H_8$.** Rietz, R.R.; Edelstein, N.M.; Ruben, H.W.; Templeton, D.H.; Zalkin, A. (Univ. of California, Berkeley). *Inorg. Chem.;* **17**: No. 3, 658-660(Mar 1978).

Uranium (IV) borohydride reacts quantitatively with tetrahydrofuran to form $U(BH_4)_4.2OC_4H_8$, a pale green solid which has been characterized by single-crystal x-ray diffractometry. This air-

and moisture-sensitive compound can be sublimed at 50 to 60°C and 10^{-5} mm. $U(BH_4)_4.2OC_4H_8$ is orthorhombic with a = 7.134 (4) A, b = 11.311 (6) A, c = 10.442 (7) A, and Z = 2, (d/sub x/ = 1.74 g cm^{-3}). The space group is Pnc2 or Pncm. For 789 data, where I greater than 2 sigma, the structure refined to R = 0.027 and R/sub w/ = 0.032 in space group Pncm, with disorder in both the THF and boron positions. The complex is a monomer with a distorted-octahedral arrangement about the uranium of four borohydride groups and two THF moelcules. The U—O distance is 2.47 (1) A. The U—B distance of 2.56 (4) A is characteristic of the triple-hydrogen-bridge bonds found in uranium (IV) borohydride. A configuration is assigned to the hydrogen atoms which places 12 of them at the corners of an hexagonal antiprism, capped by the two oxygen atoms of THF, giving the uranium atom 14 nearest neighbors. This compound is the only known uranium borohydride complex which is monomeric in the solid state. 3 tables, 3 figures.

35777 Preparation and crystal structure of uranium(IV) borohydride-n-propyl ether. Zalkin, A.; Rietz, R.R.; Templeton, D.H.; Edelstein, N.M. (Univ. of California, Berkeley). *Inorg. Chem.;* **17**: No. 3, 661-663(Mar 1978).

Uranium(IV) borohydride reacts with di-n-propyl ether to form $U(BH_4)_4.O(n\text{-}C_3H_7)_2$, a light green solid that can be sublimed at 30 to 40°C and 10^{-5} mm. Structural characterization by single-crystal x-ray diffractometry has shown the molecule to contain two uranium atoms in different environments. One uranium atom is bonded to oxygen of two ether molecules and via 11 hydrogen atoms to 4 borohydride ions. The other uranium has 14 hydrogen neighbors from 5 borohydride ions, one of which acts as a bridge to the first uranium atom. This unsymmetrical dimer is in marked contrast to the linear polymeric chain structures of $U(BH_4)_4.O(CH_3)_2$ and $U(BH_4)_4.O(C_2H_5)_2$. The propyl compound is triclinic, space group P anti 1, with a = 12.043 (10) A, b = 10.340 (8) A, c = 14.752 (13) A, α = 82.81 (5)°, β = 112.99 (5)°, γ = 110.76 (5)°, Z = 4, and d/sub calcd/ = 1.68 g cm^{-3} at 22°C. R = 0.063 for 833 reflections, with I greater than 3 sigma and with restraints on the bond distances and some of the bond angles. 2 tables, 3 figures.

35778 Study of technetium—penicillamine complexation: preparation and characterization of the complex. Fielder, F.M. Austin, TX; Univ. of Texas (1977). 168p. University Microfilms Order No. 77-29,025.

Thesis (Ph. D.).

Technetium-penicillamine, a cholescintigraphic agent, was prepared and characterized. ^{99}Tc permitted production of quantitative yields of the complex. D-(-)-penicillamine was used as the dibasic ligand molecule. An aqueous solution of ammonium pertechnetate was added to penicillamine and the reaction product purified by recrystallization. Radiochromatography confirmed the presence of technetium in the complex. Elemental (C, H, N, and S) analysis, infrared and NMR spectroscopy verified that a pure compound had been isolated. Tentative structural conclusions were reached on the basis of NMR, ir, and elemental analytical data. First, an octahedral bis-penicillamine diaquo complex was proposed on the basis of elemental analysis. Additionally, chelation by the sulfur and amino moieties of penicillamine was indicated by the IR spectral data. The predominance of the trans-isomer was sggested by NMR spectroscopy. Potentiometric titrations gave data for the determination of the stability constants of the complex species. In penicillamine solutions containing pertechnetate ions, he major complex species are TcL^{+2}, TcL_2, $TcHL^{+3}$, $Tc(HL)^{+1}$, and $Tc(HL)_2^{+2}$. The study of the stability constants led to the following conclusions: (1) Technetium is reduced by penicillamine, in the formation of the complex. (2) Technetium is present in the complex in the (IV) oxidation state. (3) Mononuclear complexes are formed. (4) The complexes are stable in aqueous solution. (5) The highest metal: ligand ratio attained in the complexes is 1 : 2. (6) The protonated mononuclear complexes appear to be the most stable complexes in aqueous solution. (7) Complexes in which technetium is chelated by the ligand molecule are more resistant to oxidation than previously thought to be. (DLC)

35779 Atomic uranium spectroscopy for laser separation. Levin, L.A.; Miron, E.; Erez, G.; Lavi, S. (Univ. of the Negev, Beer Sheva, Israel). pp 137-144 of Laser 77 opto-electronics. Conference proceedings. Waidelich, W. (ed.). Surrey, Eng.; IPC Science and Technology Press Limited, IPC House (1977).

From Laser opto-electronics conference; Munich, F.R. Germany (20 Jun 1977).

See CONF-7706116—.

A primary requirement for laser isotope separation of atomic uranium is a knowledge of the spectroscopic parameters of the uranium atom. Over 1500 atomic energy levels have been identified by classical spectroscopic techniques and isotope shifts measured for most of them. The introduction of laser excitation has broadened the range of measurable parameters to include level lifetimes, excitation and ionization cross sections and identification of previously inaccessible energy levels. The parameters of atomic uranium which must be measured for practical laser isotope separation are discussed. A spectroscopic apparatus based on laser-induced fluorescence has been developed in our laboratory. Measurements of parameters of atomic uranium are presented.

35780 (RFP-Trans—237) **Contribution to study of the hydrolysis of uranium(VI) in nitric solution.** Mavrodin-Tarabic, M. Translated from *Rev. Roum. Chim.;* **19**: No. 9, 1461-1470(1974). 10p. Dep. NTIS, PC A02/MF A01.

The nature and stability of ionic species formed by hydrolysis of uranium (VI) in nitric solution was studied by pH-metry (the mathematical analysis of differential pH-metric curves, the formation-function method and the "core + links" method). The conclusion is drawn that hydrolysis of uranium in nitric solution occurs by a series of pH-dependent reactions which lead to formation of polynuclear complexes of the "core + links" type. The ionic species that are formed are less stable in nitric solution than in the inert solution of perchloric acid.

35781 (RFP-Trans—236) **Contribution to the study of the hydrolysis of the UO_2^{2+} ion in perchloric solution.** Mavrodin-Tarabic, M. Translated from *Rev. Roum. Chim.;* **18**: No. 4, 609-621(1973). 13p. Dep. NTIS, PC A02/MF A01.

The nature of the ionic species formed by hydrolysis of uranium (VI) is determined by the "formation function" method and by the "core + links" method. The conclusion is drawn that the only uranium VI ion formed in the solution up to pH = 2.5 is the UO_2^{2+} ion, but at pH > 2.5, the UO_2^{2+} ion is hydrolyzed by a series of reactions which lead, even in very dilute solutions, to formation of polynuclear complexes of the "core + links" type, characterized by the general formula $UO_2[(OH)_2UO_2]^{2+}$/sub n/.

35782 (RFP-Trans—238) **Investigation of uranyl ion complexes in concentrated chloride, perchlorate and nitrate solutions.** Celeda, J.; Jedinakova, V.; Smirous, F. Translated from *Chem. Zvesti;* No. 22, 93-101(1968). 11p. Dep. NTIS, PC A02/MF A01.

Uranyl ion complexes in electrolyte solutions with concentrations of 1 to 5 or 1 to 10 M Cl^-, 1 to 7 or 1 to 9 M ClO_4^- and 1 to 5 or 1 to 10 M NO_3^- were tested by the method of apparent molar volume of ions and by paper ionophoresis. Ion associations and internal acid complexes were differentiated by the above methods. The composition and overall coordination number of internal acid complexes of hexavalent uranium in solution were determined, and the concentration stability constants of these complexes as well as the ion association constants were determined.

RADIOISOTOPE PRODUCTION

35783 (CONF-771075—2) **Optimum collection time for short-lived isotopes.** Lerner, J. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 18p. Dep. NTIS, PC A02/MF A01.

From 6. annual conference of the International Nuclear Target Development Society; Berkeley, CA, USA (19 Oct 1977).

In dealing with an isotope whose half-life is comparable to the processing time, the target-maker wishes to terminate the procedure at a point that will maximize the amount of the desired material on the target. This cut-off time is not always easy to determine; while it is true that fresh material is constantly being deposited, the isotope previously laid down is steadily decaying, and in addition the rate at which fresh material is applied is usually decreasing. The purpose of this paper is to determine a rule-of-thumb that can be used by the operator, during the deposition process, to yield the maximum amount of collected isotope.

COMBUSTION CHEMISTRY

35784 (LBL—7233) **Numerical analysis of flow fields generated by accelerating flames.** Kurylo, J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Dec 1977. Contract W-7405-ENG-48. 291p. NTIS, MF A01.

Portions of document are illegible. Thesis.

Presented here is a numerical technique for the analysis of non-steady flow fields generated by accelerating flames in gaseous media. Of particular interest in the study is the evaluation of the non-steady effects on the flow field and the possible transition of the combustion process to detonation caused by an abrupt change in the burning speed of an initially steady flame propagating in an unconfined combustible gas mixture. Optically recorded observations of accelerating flames established that the flow field can be considered to consist of non-steady flow fields associated with an assembly of interacting shock waves, contact discontinuities, deflagration and detonation fronts. In the analysis, these flow fields are treated as spatially one-dimensional, the influence of transport phenomena is considered to be negligible, and unburned and burned substances are assumed to behave as perfect gases with constant, but different, specific heats. The basis of the numerical technique is an explicit, two step, second order accurate, finite difference scheme employed to integrate the flow field equations expressed in divergence form. The burning speed, governing the motion of the deflagration, is

expressed in the form of a power law dependence on pressure and temperature immediately ahead of its front. The steady wave solution is obtained by the vector polar interaction technique, that is, by determining the point of intersection between the loci of end states in the plane of the two interaction invariants, pressure and particle velocity. The technique is illustrated by a numerical example in which a steady flame experiences an abrupt change in its burning speed. Solutions correspond either to the eventual reestablishment of a steady state flow field commensurate with the burning speed or to the transition to detonation. The results are in satisfactory agreement with experimental observations.

35785 Modern diagnostics for the measurement of fluctuating quantities in flames. Gupta, A.K. (Massachusetts Inst. of Tech., Cambridge); Swithenbank, J.; Beer, J.M. *J. Inst. Fuel;* **50**: No. 405, 163-169(Dec 1977).

In turbulent flames, information on the fluctuating quantities, such as fluctuating temperatures, pressures, velocity and concentration is necessary since instantaneous values of these fluctuating quantities are responsible for the mixing of reactants and for the process of reaction. During the years different devices have been developed to measure some of these quantities. A brief summary is presented of some of the new techniques developed for the direct measurement of fluctuating quantities in flames. Among the different measuring devices, the main ones presented in this paper are: compensated thermocouple for the measurement of fluctuating temperatures, horn coupled microphone probe for the measurement of fluctuating pressure and velocity, laser doppler anemometry for the measurement of fluctuating velocity, and laser Raman spectroscopy for the measurement of concentration. 8 figs.

35786 Structural and hydrodynamic conditions of fuel combustion in a low-temperature fluidized bed. Syromyatnikov, N.I.; Kulikov, V.M.; Korolev, V.N. (Urals Polytech. Inst., Sverdlovsk, USSR). *J. Inst. Fuel;* **50**: No. 405, 169-171(Dec 1977).

Experimental measurements on the bed voidage variation and gas flow adjacent to immersed surfaces within fluidized beds are reviewed. Their significance in relation to combustor bed to surface heat transfer is briefly discussed.

35787 Energy analysis for high-temperature gases. Bradley, D.; Gupta, M.L. (Univ. of Leeds, Eng.). *J. Inst. Fuel;* **50**: No. 405, 214-220(Dec 1977).

The energy cost of obtaining energy in the form of high-temperature gases, at temperatures in excess of the ideal temperature for stoichiometric methane-air combustion, is obtained theoretically for a variety of systems. These include those based upon recuperative preheating of the reactants, the combustion of methane with oxygen and oxygen-enriched air, electrically augmented flame gases, and plasma arcs. In the analyses, methane and air are assumed to be the primary sources of energy. The results show the variations of energy cost with gas temperature and component efficiencies for the different overall systems. The computations show a high economy of energy with the recuperative preheater system and a low economy with that of the arc plasma. Oxygen-enriched air systems can be more economic than those based upon pure oxygen. Up to a certain value of gas temperature, electrical augmentatiion of the energy of methane-air flame gases is more economic than systems based upon pure oxygen.

35788 Experimental investigation of coaxial turbulent jets. Bornstein, J.; Lederman, S. (Polytechnic Inst. of New York, Farmingdale). pp 443-455 of Laser 77 opto-electronics. Conference proceedings. Waidelich, W. (ed.). Surrey, Eng.; IPC Science and Technology Press Limited, IPC House (1977).

From Laser opto-electronics conference; Munich, F.R. Germany (20 Jun 1977).

See CONF-7706116—.

The application of nonintrusive diagnostic techniques for the experimental analysis of turbulent flow fields has been investigated. Raman scattering and LDV techniques have been utilized to determine temperature, specie concentration, and velocity in a coaxial-jet and a methane-air flame. Comparison of the results with those obtained using conventional methods, such as hot wire anemometry, thermocouples and gas chromatography were made. The results compare favorably with theoretical predictions.

ENGINEERING

FACILITIES AND EQUIPMENT

REFER ALSO TO CITATION(S) 35073

35789 (TID—28279) Preliminary evaluation of tubular ceramic heat exchanger materials. Final report. Mann, D.L.; Styhr, K.H. (AiResearch Casting Co., Torrance, Calif. (USA)). 8 Dec 1977. Contract EX-76-C-01-2131. 72p. Dep. NTIS, PC A04/MF A01.

The objective of this program was to identify promising new silicon carbide based materials, commercially available on a small scale, and to perform limited tests to obtain preliminary information on the applicability of these materials in stationary heat exchangers exposed to corrosive, high-temperature environments. Three types of alternate silicon carbide based materials were considered for evaluation: chemically vapor-deposited (CVD) silicon carbide (SiC); sintered silicon carbide; and composite carbon fiber reinforced, siliconized silicon carbide Si (SiC/C). The material specimens were subjected to nondestructive evaluation tests; a helium permeability measurement at 500 psi pressure at room temperature; a corrosion/erosion sequence consisting of rapid thermal cycling in 3000°F combustor gas followed by a coal slag deposition and coal slag meltoff test; and a determination of room temperature hoop tensile strength by internal pressurization to failure. Post-test evaluation included examination for microstructural changes or indications of attack by exposure to molten coal slag. On the basis of both material availability and test results from this program, it is concluded that both CVD SiC and sintered SiC are suitable as alternate materials to siliconized SiC for high-temperature heat exchanger applications.

35790 Stirling-cycle rotating magnetic refrigerators and heat engines for use near room temperature. Steyert, W.A. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Appl. Phys.;* **49**: No. 3, 1216-1226(Mar 1978).

The application (or removal) of a magnetic field to the ferromagnetic Gd metal near its Curie point (293 K) will produce adiabatic heating (or cooling) of 14 K or isothermal expulsion (or absorption) of 32 kJ of heat per liter of Gd metal. A refrigerator and a heat engine are described for which porous Gd metal forms the rim of a wheel rotating into and out of a magnetic field region. Fluid forced to flow through the porous metal exchanges heat; the field and flow configurations are such that the metal executes a magnetic Stirling cycle allowing a very wide temperature span (many times 14 K) while maintaining the 32-kJ/l capacity. Efficiencies approaching that of Carnot are expected at 1-Hz rotation rates, resulting in 32-kW/l refrigeration or heating capacity.

35791 Intensity of heat transfer at the boiling section of evaporative thermosiphons. Bezrodnyi, M.K.; Alekseenko, D.V. (Kiev Polytech Inst, Ukr SSR). *Teploenergetika (Moscow);* No. 7, 83-85(Jul 1977). (In Russian).

Results are presented of an experimental investigation of heat transfer of boiling liquids in closed two-phase coreless heat pipes (thermosiphons), depending on their geometrical dimensions, the type of the working fluid, and pressure in the inner cavity. The experiments are carried out on water ethanol, methanol, freon-11, and freon-113. As a result of the investigation and generalization of experimental data, specific features of heat transfer of boiling liquids in the thermosiphons, compared with the corresponding data for large-volume conditions, are revealed. 16 refs.

35792 Diaphragm arrangement for adjustable aperture, especially for erecting a radiation beam. Pollermann, M. (to Kernforschungsanlage Juelich Gesellschaft mit beschrankter Haftung). US Patent 4,027,167. 31 May 1977. Priority date 28 Jun 1974, German, Federal Republic of (F.R. Germany). 14p.

The invention discloses an adjustable diaphragm arrangement, or device, for defining an aperture which confines a beam of radiation, especially for radiation therapy, in which cup shaped diaphragm elements, the edges of which define the edge of the aperture and which elements are concave toward a common point at or near the source of radiation, are tiltably mounted for simultaneous movement to control the size of the aperture, and may, in addition, be rotatable to vary the orientation of the aperture, all of the aforesaid movements being carried out without change in the axis of the beam of radiation. The parts of the device may be formed of a material which strongly absorbs radiation.

35793 Experimental investigation of laminar flow of a liquid with a free surface in triangular-shaped channels. Panevin, I.G.; Smolin, M.G. *Fluid Dyn. (USSR) (Engl. Transl.);* **12**: No. 1, 142-144(Jan-Feb 1977).

At present heat pipes are used in a number of heat-engineering systems for removal and transfer of high heat fluxes. The magnitude of the heat flux transferred along the heat pipe in many respects is determined by the liquid flow rate in capillaries. In the present work results are given of an experimental study of laminar liquid flow with a free surface in triangular-shaped channels with tangential frictional stress at the free surface. Experiments were carried out when the liquid flow in inclined triangular-shaped channels had Reynodls numbers $R < 10$ and the working range of Reynolds numbers of the approach air stream was $R = 1.6$ to $3.6/10^4$. The data are presented in relative coordinates as a dependence of the hydraulic resistance coefficient of the liquid on the tangential frictional stress at the free surface. It is shown that with an increase of

the tangential frictional stress the hydraulic resistance coefficient considerably increases.

CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES

REFER ALSO TO CITATION(S) 34965, 34966, 36541, 36542

35794 (UCRL—80637) **Superconductor development program at Lawrence Livermore Laboratory.** Cornish, D.N. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 Jan 1978. Contract W-7405-ENG-48. 8p. (CONF-780124—1). Dep. NTIS, PC A02/MF A01.

From Workshop on the development of superconductors for fusion power; Germantown, MD, USA (26 Jan 1978).

Winding of a Nb—Ti test coil at the Lawrence Livermore Laboratory is nearly complete. The conductor in this coil operates in a maximum field of 7.5 T and provides the 2-T field required by the Mirror Fusion Test Facility. Nb_3Sn multifilamentary conductors, made using the "bronze" technique, appear capable of providing the higher fields needed by commercial reactors.

35795 **Rotating Carnot-cycle magnetic refrigerators for use near 2 K.** Steyert, W.A. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Appl. Phys.;* **49**: No. 3, 1227-1231(Mar 1978).

The application or removal of a magnetic field of order 5 T to some Gd compounds at low temperatures results in 10-20 K adiabatic temperature changes or the isothermal expulsion or absorption of heat. In particular, the heat absorbed by 1 liter of appropriate magnetic material at 2 K is several hundred J. A rotating device is decribed which will allow cycle times of much less than 1 sec, resulting in approximately 1-kW refrigeration capacity for each liter of paramagnetic Gd compound. This heat could be expelled with better than 80% of Carnot efficiency into a helium refrigerator operating at 10-14 K.

35796 **Applications of superconductivity to electric power equipment.** Keller, W.E. (Los Alamos Scientific Lab., NM). *Electr. Power Syst. Res.;* **1**: No. 1, 21-39(Sep 1977).

A brief survey is presented of the potential applications of superconductive devices to electric power systems. Areas of principal interest include high-capacity transmission, energy storage, and power generation by rotating machinery, magnetohydrodynamics and nuclear fusion. Some elements of superconductivity are discussed, including the properties of appropriate materials; these superconductive devices vis-a-vis the conventional counterparts in terms of reduction of power losses, decreased weight and size, and increased current capacity. An assessment is made of the time frame and the possibilities for introduction of superconductive devices into power systems.

35797 **Cooling arrangement for the rotor of an electric machine.** Kullmann, K.; Henninger, P.; Intichar, L. (to Siemens AG). US Patent 4,037,124. 19 Jul 1977. Priority date 21 Aug 1974, German, Federal Republic of (F.R. Germany). 8p.

The invention discloses a cooling arrangement for the rotor of an electric machine with longitudinal slots having disposed therein exciter winding sections which must be cooled to a low temperature, the arrangement having a feed and discharge line, in which a multiplicity of individual cooling canals running in the circumferential direction and a multiplicity of individual radial coolant feed lines and/or discharge lines are provided for each winding section over its axial length so that the cooling arrangement can be optimized with regard to the thermodynamic pressure losses of the coolant, its temperature rise and the heat transfer conditions while at the same time achieving a favorable space factor of the conductor material within the slots.

35798 **Shorting contacts for closing a superconducting current path operated by a bellows arrangement responsive to the pressure of a cryogenic medium used in cooling the contacts.** Marsing, H.; Parsch, C.P.; Franksen, H. (to Siemens AG). US Patent 4,024,363. 17 May 1977. Priority date 14 May 1973, German, Federal Republic of (F.R. Germany). 8p.

A shorting element is described for closing a superconducting current path using contacts of a stabilized superconductor material with the contacts being brought together through the use of a mechanical actuating device, in which the contact surfaces of the contact elements are brought into contact using a pneumatic and/or hydraulic means operated by a pressure medium fed into the interior of at least one spring bellows. The shorting element, which is particularly useful in shorting superconducting magnets, is of a simple design, operationally reliable, and results in small coolant losses from the addition of heat through the shorting element.

35799 **Screening of magnetic fields of cylindrical arrangements, particularly of the fields of a turbogenerator with superconducting field winding.** von Markus, H.; Sergl, J. (Tech Hochsch, Munich, Ger). *Arch. Elektrotech. (Berlin);* **59**: No. 5, 279-289(1977). (In German).

After deriving the basic equations for the magnetic vector potential for a simple arrangement consisting of a three-phase current sheet, produced on a cylindrical surface and an external shield tube, the vector potential and field equations are given. A complex screening factor is defined. It is shown that for calculation of multiregion systems the property of every cylindrical region is determined by a four-pole network. At the terminals of this network there exist electrical and magnetic field intensities. The coaxial arrangement of several cylindrical regions leads to a recurrent network. As a practical example of the application of theory, calculation of the electromagnetic field and of the power in a turbogenerator with superconducting field winding is demonstrated. 11 refs.

35800 **Superconducting field winding for turbogenerator rotors.** Weghaupt, E. (to Kraftwerk Union A.G., Muelheim an der Ruhr (Germany, F.R.)). German(FRG) Patent 2,503,428/A/. 29 Jul 1976. 13p. (In German).

Superconducting field coils for turbogenerators are easy to produce and can be held in the grooves without clearance. Installation is carried out so as to make sure that the rotor will not be deformed on operation by different centrifugal forces. The groove filling consists partly of superconductors and partly of copper filling conductors. The windings of each groove consist of several part coils with varying cross-sectional shape. The method of installation is described.

35801 **Applications of the Josephson effects.** Giffard, R.P. (Stanford Univ., CA); Gallop, J.C.; Petley, B.W. *Prog. Quantum Electron.;* **4**: 301-402(1976).

The review concentrates on proven, rather than speculative applications, and on recently published work. The topics include magnetometry, measurement of 2 e/h and standard laboratory applications, Josephson junctions as radiation sources, Josephson junctions as logic and memory devices, and mixers and detectors. (TFD)

35802 **Josephson weak links: shunted-junction and mechanical-model results.** Hansma, P.K.; Rochlin, G.I. (Univ. of California, Berkeley). *J. Appl. Phys.;* **43**: No. 11, 4721-4727(Nov 1972).

Two models of a superconducting weak link which give physical insight into the behavior of many Josephson-effect devices have been investigated. The first of these is a low-inductance oxide-barrier Josephson tunnel with an external resistive shunt; the second is a mechanical analog, a driven damped pendulum. The behavior of both models is governed by the second-order nonlinear differential equation independently proposed by Stewart and McCumber. These models not only verify the computer-generated solutions for weak links in detail, they give new physical insight into the underlying nonlinear behavior.

SHIPPING CONTAINERS

35803 (SAND—78-0065C) **Radioactive fuel cask railcar humping study.** Wilson, L.T. (comp.). (Sandia Labs., Albuquerque, N.Mex. (USA)). 1978. Contract EY-76-C-04-0789. 11p. (CONF-780506—4). Dep. NTIS, PC A02/MF A01.

From 5. symposium on packaging and transportation of radioactive materials; Las Vegas, NV, USA (7 May 1978).

The response of two radioactive shipping casks due to railroad humping shocks was calculated using a spring-mass model. The two railcars for these casks had different coupling mechanisms and different tiedown arrangements. Humping tests had been performed on one of the railcars (ATMX-600) and the resulting shock spectra was used to adjust the spring-mass model to get matching results. One car (designed for cask shipment) was equipped with Freightmaster E-15 end of car coupler and had about $\frac{1}{8}$ in. free travel of the cask skid relative to the car. The other car (ATMX-600), equipped with Miner RF-333 draft gear, was designed for nuclear weapon shipment and adapted to nuclear waste shipment by fastening the casks to the floor. Both car frames were built by the same manufacturer and are very similar. The response of the casks was put in shock spectra format and a parametric study was performed with various cask weights. Additional studies were done on the effects of fastening the loose cask, and using the Freightmaster end of car coupler on the ATMX car. Half-sine response spectra were overlaid to include the natural frequency of the cask tiedown. The resulting shock amplitude was plotted against the cask weight for each car. The results show a constant acceleration level for all the weights on the car with hydraulic end-of-car coupler which results from constant force at that impact velocity. The cask acceleration can be reduced by fastening it to the car, rather than allowing it to move freely through some small space. This study also shows that the cask response can be optimized on railcars without hydraulic draft gear by adjusting the tiedown stiffness to keep the tiedown frequency different than car frequencies.

TRANSPORT AND STORAGE FACILITIES

35804 Giant Czech pipeline project. Michl, A. *Indian East. Eng.;* **119**: No. 7, 345, 347(Jul 1977).

A description is given of the complex transit gas pipeline project undertaken by Czechoslovakia. It began in 1971 and will be completed in 1979. The pipeline will be 2250 km long and deliver 3700 million m^3 of gas every year. Current work and future prospects are discussed.

MINING AND DRILLING EQUIPMENT AND FACILITIES

REFER ALSO TO CITATION(S) 34431

35805 Acoustic isolation for a telemetry system on a drill string. Matthews, H.B. (to Sperry Rand Corp.). US Patent 4,066,995. 3 Jan 1978. Filed date 12 Jan 1975. 4p.

A system for the transmission of data along a borehole during drilling operations which includes an acoustic transmitter receiver and mechanical filters is described. Data is acoustically propagated from the transmitter to the receiver along a portion of the drill string which is isolated from noise generating elements of the drilling system by means of the mechanical filters.

35806 Method and system for determining formation porosity. Pittman, R.W.; Hermes, C.E. (to Texaco Inc.). US Patent 4,064,749. 27 Dec 1977. Filed date 11 Nov 1976. 24p.

The invention discloses a method and/or system for measuring formation porosity from drilling response. It involves measuring a number of drilling parameters and includes determination of tooth dullness as well as determining a reference torque empirically. One of the drilling parameters is the torque applied to the drill string.

35807 Selectively actuated vibrating apparatus connected with well bore member. Yandell, J.L. US Patent 4,058,163. 15 Nov 1977. Filed date 9 Jul 1976. 8p.

A vibrating apparatus connected with a member insertable into a well bore including an insertable and retrievable member enabling the vibrating apparatus to be selectively actuated is described. The vibrating apparatus includes a rotatable, eccentric weight forming a rotor having selectively closable through passage means and bypass means oriented to impart rotation of the eccentric weight when the through passage is closed and pressurized fluid is required to pass through the bypass for discharge in offset relation to the axis of rotation for rotating the eccentric weight thereby vibrating the apparatus and the well bore member to which it is attached. In one embodiment of the invention, the through passage is closed by a vall valve which can be inserted into the flow passage at ground surface for movement into engagement with a valve seat by gravity together with a magnet insertable into the flow passage for retrieving the ball valve which is subject to magnetic attraction. Another embodiment of the vibrating apparatus includes an insertable plug having a spiral passageway peripherally thereof with the plug being locked to the rotatable eccentric weight when inserted into the flow passage and provided with a passageway communicating with the spiral passageway for guiding fluid pressure therethrough. A third embodiment involves the construction of the vibrating apparatus of drillable material to enable it to be effectively used when running in well casings or the like.

35808 Well bore communication method. Scherbatskoy, S.A. US Patent 4,057,781. 8 Nov 1977. Filed date 19 Mar 1976. 14p.

A logging while drilling apparatus, included in a rotatable drilling string of drill pipe disposed in a well bore, is disclosed. The apparatus generally includes a combination communication system comprising two communication channels coacting in cascade or tandem fashion with a first lower communication channel having very low attenuation characteristics but being relatively inconvenient to connect or disconnect and with a second upper communication channel having greater attenuation characteristics but being very convenient to connect or disconnect when adding drill pipe as drilling continues. Electrical power for the entire combination in the well bore is provided from a location remote from the bottom of the well. Also discussed are related methods of logging while drilling.

35809 Optimum bit geometry for rotary drilling of boreholes in hard rocks. Kulishenko, I.I.; Kovalev, V.I.; Vasil'chenko, V.F.; Sologub, S.Y. (Polytechnic Inst., Gorlovka, USSR). *Sov. Min. Sci. (Engl. Transl.);* **12**: No. 6, 612-614(1976).

Translated from Fiz.-Tekh. Probl. Rzarab. Polezn. Iskop.; 12: 6, 59-62(1976).

As a result of the investigations we obtained graphs of the drilling speed and volumetric work of fracture vs the axial thrust. Analysis of these graphs reveals that the drilling speed of the RBT-3G increases about 1.85 times faster with the borehole length than that of the RB-42-2 and about 1.42 times faster than that of the RPKh-3; this is due to the lower relative wear of the bit under test. Industrial tests revealed that drilling bits of type RBT-3G with the new geometry, with $\alpha = -25^0$, $\beta = 85^0$, $\gamma = 30^0$, give the best results both with regard to strength and durability and with regard to drilling speed in comparison with the commercially produced RB-42-2 and experimental RPKh-3 bits. Cylindrical hard-alloy plates with guides with a rake angle of -25° and backing-off angle of 85 to 90° give a uniform state of compressive stress. The use of hard-alloy plates of the recommended geometry permits us to create a rock-breaking tool of increased strength and durability with better operational characteristics than those of the bits presently in use.

LASERS

REFER ALSO TO CITATION(S) 34678, 36572

35810 (ORO—5005-16) **Spectroscopic studies of ultraviolet lasing transitions in diatomic molecules. Final report, November 1, 1975—October 31, 1977.** Tellinghuisen, J.B. (Vanderbilt Univ., Nashville, Tenn. (USA)). 1977. Contract EY-76-S-05-5005. 23p. Dep. NTIS, PC A02/MF A01.

Beginning in 1975 workers in several laboratories have developed a new class of lasers which operate on transitions in the diatomic noble gas halide (AX) molecules. Specifically, lasing was achieved for XeBr (2820 A), XeCl (3080 A), XeF (3510 and 3530 A), KrCl (2220 A), KrF (2490 A), ArCl (1750 A), and ArF (1930 A). In similar experiments, lasing was also reported for UV transitions in I_2 (3420 A), Br_2 (2920 A), and F_2 (1580 A). Since the initial reports, dozens of papers have been published on these new lasers, and the rare gas fluoride lasers are now available commercially. The AF lasers have been made to operate with moderate efficiency (1 to 3 percent) and high pulse power (10^9 W), hence are of possible practical import in laser isotope separation schemes and military applications. All of these new UV lasers appear promising as laboratory research tools. The work performed under this contract has contributed greatly toward a better fundamental spectroscopic understanding of these UV lasing transitions.

35811 (SAND—77-0157) **Laser-fusion research progress report, July—December 1976.** (Sandia Labs., Albuquerque, N.Mex. (USA)). May 1977. Contract EY-76-C-04-0789. 103p. Dep. NTIS, PC A06/MF A01.

A separate abstract has been prepared for each of the six sections of the report. (TFD)

35812 (SAND—77-0157, pp 15-31) **Iodine laser program: SAIL-1.** May 1977.

In Laser-fusion research progress report, July—December 1976.

The iodine laser is the most highly developed near-infrared gas laser available for large-scale laser development. Its fast-repetition-rate potential and prospects for improvements in efficiency make it a primary laser candidate to meet mid-term laser-fusion requirements. It may have adequate efficiency for commercial laser-fusion applications in a hybrid fission/fusion reactor, for fusion-fuel breeding and for laser-fusion power generation using complex pellets. Research progress is reported on: (1) SAIL-1; (2) iodine laser-code development; (3) collision and radiation coupling for iodine atoms; (4) development of multilevel Block-Maxwell equations; (5) approximations for iodine amplifiers; and (6) studies based on the ISTAR code. (TFD)

35813 (SAND—77-0157, pp 32-60) **HF laser program.** May 1977.

In Laser-fusion research progress report, July—December 1976.

The goal of this program is to determine whether the HF laser, in particular, and high-gain lasers in general, can contribute to the mid-term and long-term laser requirements of laser fusion. Research progress is reported on: (1) HF oscillator-amplifier studies using H_2—F_2 mixtures; (2) HF amplifier for oscillator-amplifier studies; (3) ablation technique for obtaining focal spot intensity distribution; (4) calorimeter for measuring laser beam spot size; (5) infrared photography at 3 microns; (6) high-pressure H_2—F_2 laser studies; (7) numerical modeling of HF laser performance; (8) feasibility of producing a short-pulse, multiline, diffraction-limited oscillator for extraction of energy from an electron-beam-initiated H_2—F_2 amplifier; (9) stability of static multiatmosphere H_2—F_2 mixtures; (10) repetitively ignited flowing H_2—F_2—O_2 mixtures; (11) fluid mechanics of a repetitively pulsed, flowing, H_2/F_2 laser; (12) numerical modeling of HF laser-mixing processes; (13) time-sequenced energy extraction on the high-gain Xe laser; (14) modeling the atomic xenon laser; and (15) the effect of transverse ASE in a high-gain, two-level amplifier.

35814 (SAND—77-0157, pp 60-69) **Power conditioning for Group VIA (^1S) atoms.** May 1977.

In Laser-fusion research progress report, July—December 1976.

Group VIA atoms are promising candidates for laser-fusion lasers. The laser transition is $p^4\ ^1S \rightarrow p^4\ ^1D$, which permits long-time energy storage since it is metastable and is relatively resistant to deactivation by many species that are common to gas-laser media. The laser wavelengths for the various Group VIA atoms (O, S, Se, Te) are in the range from 558 to 790 nm—favorable wavelengths for laser fusion and for optical components. The emphasis in the program is presently placed on $O(2^1S)$ as the prototype atom because more kinetic data are available for it than are available for the other Group VIA atoms, and the technology developed in this study should be applicable to the other Group VIA atoms.

35815 (SAND—77-0157, pp 69-81) **Laser-excitation-source development.** May 1977.

In Laser-fusion research progress report, July—December 1976.

A number of schemes can be used to excite a gas laser, which introduces complexity in the search for the new laser because it requires the development of a host of advanced excitation sources. There are three demonstrated schemes for the excitation of a gas laser: (1) electron beam, (2) electric discharge, and (3) photolytic pumping. The photons for photypic pumping may be obtained with the other two excitation mechanisms in an external gas cell. Thus, from a power conditioning point of view, there are only two important excitation schemes, but each scheme has many different options. Research progress is reported on direct electric-discharge excitation development. (TFD)

35816 (SAND—77-0157, pp 81-85) **Laser-development-related studies and facilities.** May 1977.

In Laser-fusion research progress report, July—December 1976.

Research progress is reported on: (1) noble gas halide lasers; (2) scaled electron ionization cross sections; and (3) laser cavity calculations. (TFD)

35817 (SAND—77-1517) **Laser development for laser fusion applications. Research progress report, January—September 1977.** (Sandia Labs., Albuquerque, N.Mex. (USA)). Feb 1978. Contract EY-76-C-04-0789. 83p. Dep. NTIS, PC A05/MF A01.

A separate abstract was prepared for the three sections of the report. (TFD)

35818 (SAND—77-1517, pp 11-50) **HF-laser program.** Feb 1978.

In Laser development for laser fusion applications. Research progress report, January—September 1977.

Sandia's HF-laser program for FY 77 and FY 78 was revised in June 1977 in order to meet several new program milestones. Research progress is reported on: objective of HF oscillator-amplifier studies using H_2-F_2 gas mixtures; characteristics of large-volume oscillator using H_2-F_2 mixtures; characteristics of large-volume amplifier using H_2-F_2 mixtures; experimental results of the oscillator-amplifier study; objective of high-quality discharge-initiated SF_6-HI oscillator-preamplifier system; pin-discharge-initiated oscillator and first beam expander; fast-discharge-initiated preamplifiers; reflecting beam expanders for oscillator-preamplifier system; beam quality of discharge-initiated oscillator-preamplifier system; short pulse option for discharge initiated SF_6-HI system; H_2-F_2 electron-beam-initiated oscillator-preamplifier system; chamber for HF-laser focusing experiments; computer study of parasitic oscillations in HF amplifiers and oscillators; kinetics upgrade of HF-laser code; repetitivey ignited flowing H_2-F_2-O_2 mixtures; spontaneous detonations in multiatmosphere H_2-F_2-O_2 mixtures; high-pressure H_2-F_2 laser studies; and time sequenced energy extraction on the high xenon laser. (TFD)

35819 (SAND—77-1517, pp 50-77) **Iodine laser program.** Feb 1978.

In Laser development for laser fusion applications. Research progress report, January—September 1977.

Experimental studies during this report period emphasized evaluation of beam quality in saturated and unsaturated amplifiers, pulse distortion, efficiency and code development. The codes are now in good shape, and little further development is needed in order to confidently design more complex systems. Chemical kinetic modeling has been used to predict starting material consumption in an iodine laser, and a study of chemical regeneration has been initiated. (TFD)

35820 (SAND—77-1517, pp 77-86) **Power conditioning for Group VIA (^1S) atoms.** Feb 1978.

In Laser development for laser fusion applications. Research progress report, January—September 1977.

The class of gas-laser systems based on the excitation of the p^4 ^1S state of Group VIA atoms (e.g., O, S, Se, Te) with energy extraction on the $p^4\ ^1S \rightarrow p^4\ ^1D$ or $p^4\ ^1S \rightarrow p^4\ ^3P$ transition is an extremely promising one for laser-fusion applications. Long energy-storage times are possible since the ^1S state exhibits a long radiative lifetime and is resistant to deactivation by a wide variety of other species. Also, these transitions occur at useful wavelengths (459 to 790 nm) and exhibit stimulated emission cross sections that are low enough to inhibit parasitic amplified spontaneous emission but not so low that the medium cannot be saturated at reasonable energy fluxes. The primary difficulty with this laser system is that no efficient means of generating large densities of ^1S atoms has yet been demonstrated. A research program was implemented to evaluate three different concepts for producing Group VIA (^1S) atoms. The three concepts involved in-situ electron-beam-excited rare-gas metastable energy transfer; in-situ electron-beam-excited photolytic energy transfer; and extra-cavity photolytic energy transfer. An evaluation of the first two concepts is contained in the previous report. Research progress is reported on the third concept. (TFD)

35821 (UCRL—80490) **Forbidden transition selenium atom photodissociation lasers.** Powell, H.T.; Ewing, J.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Dec 1977. Contract W-7405-ENG-48. 5p. (CONF-780510—4). Dep. NTIS, PC A02/MF A01.

From 10. quantum electronics conference; Atlanta, GA, USA (May 1978).

Weak laser oscillation has been demonstrated on the 489 and 777 nm elecric dipole forbidden $^1S_0$-$^3P_1$ and $^1S_0$-$^1D_2$ transitions of the selenium atom. Carbonyl selenide has been photolyzed at 172 nm by Xe_2 radiation to produce the $Se(^1S_0)$ excited state.

35822 (UCRL—80495) **Injection locked, unstable resonator KrF discharge laser with linewidth of 3 GHz.** Murray, J.R.; Goldhar, J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Dec 1977. Contract W-7405-ENG-48. 4p. (CONF-780510—3). Dep. NTIS, PC A02/MF A01.

From 10. quantum electronics conference; Atlanta, GA, USA (May 1978).

The full 100 mJ output of a KrF TEA laser has been extracted in a mode of high spatial quality and with a linewidth as low as 3 GHz (0.1 cm^{-1}).

35823 **Backward Raman gain measurements for KrF laser radiation scattered by CH_4.** Murray, J.R.; Goldhar, J.; Szoeke, A. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Appl. Phys. Lett.;* **32**: No. 9, 551-553(1 May 1978).

Backward Raman small-signal gain measurements for a KrF laser scattered by methane gas, including linewidth and pressure dependences, are presented. A 268-nm probe beam is produced from a 249-nm pump beam by superfluorescent emission in a methane cell, and is amplified by a counterpropagating KrF beam at 249 nm in a second methane cell. The results are consistent with theoretical predictions for the backward Raman amplifier.

35824 **1-mJ line-tunable optically pumped 16 μm laser.** Osgood, R.M. Jr. (Lincoln Laboratory, Massachusetts Institute of Technology, Lexington, Massachusetts 02173). *Appl. Phys. Lett.;* **32**: No. 9, 564-566(1 May 1978).

A optically pumped CO_2 laser, which is excited by a 100-mJ HBr laser, produces 1 mJ of multiline energy per pulse. Extensive stepwise tuning is accomplished by means of an intracavity grating and by using various isotopic forms of CO_2. A technique which enables measurement of the CO_2 (01^10) relaxation time by HBr is described.

35825 **Generation of tunable radiation below 2000 A by phase-matched sum-frequency mixing in $KB_5O_8x4D_2O$.** Paisner, J.A.; Spaeth, M.L.; Gerstenberger, D.C.; Ruderman, I.W. (University of California, Lawrence Livermore Laboratory, P.O. Box 808, Livermore, California 94550). *Appl. Phys. Lett.;* **32**: No. 8, 476-478(15 Apr 1978).

We have investigated second harmonic generation (SHG) and sum-frequency mixing (SFG) in deuterated potassium pentaborate using N_2 laser pumped dye lasers. The crystal 90° second harmonic generates at 2161.5 A with a power conversion efficiency of 5% at an input power of 15 kW. Tunable phase-matched VUV SFG is observed from 2161.5 to 1962.4 A. Transmission and birefringence measurements indicate that the crystal can phase match with high conversion efficiencies to below 1700 A

35826 **High-energy lasing of XeBr in an electric discharge.** Sze, R.C.; Scott, P.B. (University of California, Los Alamos Scientific Laboratory, P.O. Box 1663, Los Alamos, New Mexico 87545). *Appl. Phys. Lett.;* **32**: No. 8, 479-480(15 Apr 1978).

Using an electric discharge as the excitation source we have overcome the problem of $Xe^+{}_2$ absorption and have observed lasing at 282 nm in XeBr at the 60-mJ/pulse level. HBr is used as the halogen donor. Simultaneous laser oscillation at 291 nm in Br_2 has also been observed. The present laser, however, has materials compatibility problems causing short static-fill lifetimes.

35827 **Characteristics and optimization of the two-photon-excited 16-μm laser in $^{14}NH_3$.** Pummer, H.; Bischel, W.K.; Rhodes, C.K. (Molecular Physics Center, SRI International, Menlo Park, California 94025). *J. Appl. Phys.;* **49**: No. 3, 976-979(Mar 1978).

Stimulated emission at 15.88 and 15.95 μm has been obtained in $^{14}NH_3$ utilizing two-photon excitation. Total output energies on the order of 1 mJ have been observed in configurations which can be readily scaled to higher values. A discussion of the parameters available to control the operation of this system is given along with experimental data on laser output energy, divergence, the role of the optical Stark effect, pressure dependence, and spectral control with absorbing gases. These mechanisms can be generally applied for efficient down-conversion throughout the infrared.

35828 Investigation of the sensitivity of the intercavity method of analysis using lasers on solutions of complex organic compounds. Burakov, V.S.; Kotomtseva, L.A.; Misakov, P.Ya.; Raikov, S.N. *Zh. Prikl. Spektrosk.;* **28**: No. 2, 218-223(Feb 1978). (In Russian).

The kinetics of multimode generation of a dye laser with lamp pumping with frequency selective losses in the resonator is considered on the basis of balance equations for populations and transfer equations for radiation density. A shift in the generation band maximum with an increase in the resonator base is described which is in satisfactory agreement with the experiment, as well as the possibility of compensating this shift by a change in the concentration of the dye, and the trend of concentration and absolute sensitivities with an increase in the resonator base. Results of the experiment and calculations indicate the possibility of increasing the base of the laser resonator in a 6 Zh Rhodamine laser with lamp pumping to 1.5 m without any considerable reduction in sensitivity.

35829 Features of the spectrum kinetics of a laser on polyatomic organic molecules. Gruzinskii, V.V.; Davydov, S.V. *Zh. Prikl. Spektrosk.;* **28**: No. 2, 224-232(Feb 1978). (In Russian).

An expression is found for pulse lasers on organic compounds describing the change in the wavelength of the band maximum of generated radiation lambda/sub gmax/ with time for different ratios of gain and absorption spectra and loss dynamics. The shift in time of lambda/sub gmax/ of the generated radiation band Δlambda/sub g/(t) and the change in the population of the energy level depending on properties of the active medium, parameters of the cavity and pumping conditions are analyzed. It is established that the dependencies lambda/sub gmax/(t) and Δlambda/sub g/(t) calculated on the electronic computer give a good description of known experimental data on spectrum generation kinetics over a wide range of pumping durations and powers. It is shown that the position in time of lambda/sub gmax/ and the maximum of the gain coefficient k/sub g/(lambda) do not coincide.

35830 Laser radiation spectrum and some questions of intercavity spectroscopy. Gorcharuk, I.M.; Kotomtseva, L.A.; Samson, A.M. *Zh. Prikl. Spektrosk.;* **28**: No. 2, 238-244(Feb 1978). (In Russian).

The quasistationary generation spectrum of a laser with uniformly broadened line of amplification is described on the basis of balance equations for two-level active medium populations and transfer equations for radiation density, taking into account spectral characteristics of the system and luminescence contour of the active medium. The dependence of the radiation contour on spectral characteristics of the investigated substance placed in the cavity and on the laser parameters, for a medium with dispersive contour of amplification, giving the sensitivity of the intracavity method for determining substance spectra, is considered.

35831 Calculation of the width of the synchronization region of a circular ring laser. Timofeeva, G.I. *Zh. Prikl. Spektrosk.;* **28**: No. 2, 245-249(Feb 1978). (In Russian).

The dependence of the width of the synchronization region on parameters of the active medium and of the cavity is investigated. Possible types of transition from a single-frequency to a double-frequency regime are considered.

35832 Excitation of dyes with gigantic monoimpulses of radiation. Lavrovskii, L.A.; Morgun, Yu.F.; Muravitskii, M.A.; Rishechkin, S.A. *Zh. Prikl. Spektrosk.;* **28**: No. 2, 250-254(Feb 1978). (In Russian).

An investigation was made of energy and spectral generation characteristics of cyanine dyes Nos. 3963 and 341 excited by a ruby laser with energy of the giant pulse to 30 J and a power over 1 hectowatt. The dependence of the efficiency of a liquid laser on the initial concentration of a solution of a complex nature with two maxima was studied. Laser-generated monoimpulses on organic dyes with an energy up to 6 J and a power of 200 mW were obtained.

35833 Some features of cavities of waveguide lasers. Orlov, L.N.; Seravkina, N.K. *Zh. Prikl. Spektrosk.;* **28**: No. 2, 344-346(Feb 1978). (In Russian).

A comparison of the effectiveness of cavities of waveguide length helium-neon lasers with mirrors of various curvatures was made.

35834 Calculation of CO_2 isotope-laser characteristics. Doronin, V.G.; Novikov, V.I. *Zh. Prikl. Spektrosk.;* **28**: No. 1, 50-56(Jan 1978). (In Russian).

The electrodischarge N_2:He:CO_2 laser gain and its frequency tuning range were calculated. The optimum ratios of isotope partial pressures in a binary mixture corresponding to the maximum frequency tuning range and the maximum threshold loss factor were determined. The near-axis dip is shown to appear in the gain-factor distribution along the active medium cross-section with the discharge current increase. A wide range of the continuous frequency tuning beginning with the gas pressure of 300 nm of Hg is available due to the effect of vibrational-rotational transition overlappings of the isotope molecules. The frequency tuning range depends on the partial pressure correlations and decreases with the discharge tube temperature increase. The isotope optimum pressures are slightly dependent on the tube temperature and can be easily determined by the known laser gains at each isotope taken separately.

35835 Optical cavity periodic modes. Ableckov, V.K.; Belyaev, V.S.; Vasilev, V.P.; Golovistikov, A.N.; Davydov, V.M.; Savelev, V.G. *Zh. Prikl. Spektrosk.;* **28**: No. 1, 57-59(Jan 1978). (In Russian).

The results of periodic mode-laser cavity experiments with the latticed mirror being present are described. The results obtained are in good agreement with the theoretical calculations adduced.

35836 Luminescence and stimulated radiation of neodymium nitrate-perdeuterotributylphosphate complex solutions. Goryaeva, E.M.; Shablya, A.V.; Serov, A.P. *Zh. Prikl. Spektrosk.;* **28**: No. 1, 75-80(Jan 1978). (In Russian).

The possibility of using solutions of neodymium nitrate-tributylphosphate complexes as an active medium for Nd^{3+} laser was studied on the basis of the theoretical information about the radiationless dipole-dipole energy transfer from the rare-earth ions to the molecules of the environment and the data on the structure of such complexes. The flash-tube pumped laser action of the neodymium nitrate solutions in the mixture of perdeuterotributylphosphate with hexafluorobenzene was obtained at lambda/sub max/ = 1054 nm. The luminescence quantum yield of 0.04, the cross-section of the laser transition gain sigma = $6,7 \times 10^{-20}$ cm^2 and the total losses rho = 0.0026 cm^{-1} were estimated in the solution under investigation. The threshold pumping energy per unit of the active volume in the sealed cavity amounts to 7 J/cm^3, the system efficiency equals 0.015 percent.

35837 Investigation of complex molecular solution stimulated radiation light-quenching. Rudik, K.I.; Maksimov, A.I.; Senkevich, L.P.; Kostko, M.Ya. *Zh. Prikl. Spektrosk.;* **28**: No. 1, 91-94(Jan 1978). (In Russian).

The radiation quenching efficiency in dye lasers that depend on the mutual spectral position of the generation band and the quenching radiation wavelength was investigated. Einstein coefficients for forced transitions of systems investigated at the quenching radiation frequency were calculated on the basis of the experimental data obtained. The laser radiation polarization degree under the light quenching according to the electrical vector orientation of quenching and exciting light waves was considered. The results obtained are indicative of the radiation quenching spatial selectivity in dye lasers of complex compounds.

35838 Coherent radiation of transverse-discharge pumped metal-vapor ionized lasers. Iilyushko, V.G.; Kravtschenko, V.F.; Mikhalevskii, V.S.; Polunin, V.A. *Zh. Prikl. Spektrosk.;* **28**: No. 1, 143-144(Jan 1978). (In Russian).

The possibility of the transverse discharge application for pulsed Hg—He, Cd—He lasers operating by the re-charging mechanism was demonstrated. The generation parameters are compared with generation in a hollow cathode where the recharging mechanism is the most effective. It was established that the transverse discharge produces high gains and generation powers for equal active volumes.

35839 Method of making an electrically pumped solid-state disturbed feedback laser. Scifres, D.R.; Streifer, W.; Burnham, R.D. (to Xerox Corp.). US Patent 4,023,993. 17 May 1977. Filed date 28 Aug 1975. 10p.

An electrically pumped, solid-state laser device having a grating or physical periodic structure in a region, or adjacent region, of semiconductor material that functions as a light wave guide is described. The spacing of the perturbations of the periodic structure are selected to be an integer number of half wavelengths of the desired laser wavelength. The electrically pumped, solid-state laser device can be a single heterojunction device or a double heterojunction device. Both devices are formed by a process which provides for formation of the periodic structure prior to formation of the light guiding layer or region. Due to this process a periodic structure having a desired spacing and substantial depth is produced, which structure produces Bragg Scattering which couples and reinforces light traveling through the light guiding layer in both directions in a coherent manner such that reflections are in phase, thus allowing laser operation in the absence of discrete end reflectors.

35840 Laser 77 opto-electronics. Conference proceedings. Waidelich, W. (ed.). Surrey, Eng.; IPC Science and Technology Press Limited, IPC House (1977). 782p. (In English and German). (CONF-7706116—). .

From Laser opto-electronics conference; Munich, F.R. Germany (20 Jun 1977).

A separate abstract was prepared for each of 11 of the 155 papers presented at the conference. (TFD)

35841 Excimer lasers. Brau, C.A. (Los Alamos Scientific Lab., NM). pp 49-53 of Laser 77 opto-electronics. Conference proceedings. Waidelich, W. (ed.). Surrey, Eng.; IPC Science and Technology Press Limited, IPC House (1977).

From Laser opto-electronics conference; Munich, F.R. Germany (20 Jun 1977).

See CONF-7706116—.

A number of excimer lasers have now been demonstrated spanning the spectrum from green to the vacuum ultraviolet, and others have been proposed. Although the different classes of excimer lasers have rather different properties, making them useful for different purposes, the rare gas halides have demonstrated the highest power and efficiency, and promise to be the most widely useful. Overall efficiency in excess of 1 percent and pulses as large as 350 J have been achieved from krypton fluoride, and higher efficiency and much larger pulses are predicted. A wide variety of uv wavelengths is available using stimulated Raman scattering.

35842 Electrically stimulated gasdynamic CO laser. Maisenhaelder, F. (Inst. fuer Technische Physik, Stuttgart). pp 66-75 of Laser 77 opto-electronics. Conference proceedings. Waidelich, W. (ed.). Surrey, Eng.; IPC Science and Technology Press Limited, IPC House (1977). (In German)

From Laser opto-electronics conference; Munich, F.R. Germany (20 Jun 1977).

See CONF-7706116—.

An electrically excited gasdynamic CO laser and its mode of operation are described. Stabilization of the glow discharge produced higher power densities. Specific power of 57 kJ/kg, were obtained. Operation with closed gas circuit was investigated in an attempt to increase the economy of the instrument. Studies were also made on increasing the pressure level in the system. The possibilities of electrical excitation in the supersonic range was discussed.

35843 Laser amplification unit with programmable electrooptic pulse formation. Kocher, E.R. (LASAG AG, Schweizerweg, Ger.). pp 76-81 of Laser 77 opto-electronics. Conference proceedings. Waidelich, W. (ed.). Surrey, Eng.; IPC Science and Technology Press Limited, IPC House (1977). (In German)

From Laser opto-electronics conference; Munich, F.R. Germany (20 Jun 1977).

See CONF-7706116—.

The laser amplification unit described produces laser pulses with a time-controlled intensity pattern. The pulses have a local Gaussian intensity profile at an energy from 1 to 15 W/s and a duration from 1 to 30 μs. The basis of the unit is a Nd:YAG laser oscillator-amplifier system operating in the TEM_{00} mode with a Nd-glass amplifier connected at the outlet. The transient pulse formation takes place with a programmable electro-optical transmission control before the connected amplifier. The non-linearity of the laser amplifier is theoretically known and was considered in the pulse formation.

35844 Efficient water-soluble laser dyes in the blue spectral region. Telle, H. (Univ. of Cologne); Brinkmann, U.; Raue, R. pp 82-87 of Laser 77 opto-electronics. Conference proceedings. Waidelich, W. (ed.). Surrey, Eng.; IPC Science and Technology Press Limited, IPC House (1977).

From Laser opto-electronics conference; Munich, F.R. Germany (20 Jun 1977).

See CONF-7706116—.

The classes of sulphonated triazinylstilbenes and bisstyryles were investigated systematically for their application in N_2 laser-pumped dye lasers. All tested dyes had good lasing conditions in water and methanol. In many cases the dyes—all lasing in the blue and violet spectral region—showed to be superior to other common dyes that are usually soluble in organic solvents, only. Broad tuning ranges together with high photochemical stability and good efficiency were found.

35845 Precise frequency tuning of a single-mode dye laser. Jitschin, W.; Meisel, G. (Univ., Bonn). pp 88-92 of Laser 77 opto-electronics. Conference proceedings. Waidelich, W. (ed.). Surrey, Eng.; IPC Science and Technology Press Limited, IPC House (1977).

From Laser opto-electronics conference; Munich, F.R. Germany (20 Jun 1977).

See CONF-7706116—.

A simple method has been developed which allows the tuning of a frequency stabilized dye laser. The change of the laser frequency is made equal to the frequency change of a rf oscillator. Thus high accuracy is achieved. The system uses a Pockels cell and two polarizers.

35846 Improved frequency doubling for 217-360nm. Klauminzer, G.K. (Molectron Corp., Sunnyvale, CA). pp 93-96 of Laser 77 opto-electronics. Conference proceedings. Waidelich, W. (ed.). Surrey, Eng.; IPC Science and Technology Press Limited, IPC House (1977).

From Laser opto-electronics conference; Munich, F.R. Germany (20 Jun 1977).

See CONF-7706116—.

While frequency doubling of tunable lasers has become commonplace, little attention has been given to the problem of providing an ultraviolet scan in which the doubling crystal angle is automatically adjusted to achieve phase matching. Earlier synchronization schemes have covered only a small scan range, and then only after the crystal has been set manually to a phase-matched starting point. The approach provides a fully automatic scan over the entire range of a typical second harmonic crystal.

35847 Arrangement for the energy coupling of several laser resonators. Peschel, C.; Orzegowski, H.; Schneider, H.; Thiede, G. (Zentrum fuer Wissenschaftlichen Geraetebau der AdW der DDR, Berlin). pp 97-107 of Laser 77 opto-electronics. Conference proceedings. Waidelich, W. (ed.). Surrey, Eng.; IPC Science and Technology Press Limited, IPC House (1977). (In German)

From Laser opto-electronics conference; Munich, F.R. Germany (20 Jun 1977).

See CONF-7706116—.

A solution variant was investigated for increasing the output power by optical parallel wiring of the energy of several laser resonators with a mirror-telescopic arrangement. It is then possible to couple the energy of a number of optimally tuned resonators with relatively little cost.

35848 Effect of wide-band noise on the spectral characteristics of the pulsation signal in ring lasers. Kutsak, A.A.; Strekalovskaya, E.Yu. *Zh. Prikl. Spektrosk.;* **25**: No. 4, 625-631(Oct 1976). (In Russian).

HEAT TRANSFER AND FLUID FLOW

REFER ALSO TO CITATION(S) 34850, 34908, 35187, 35259, 35279, 35788, 35791, 35793

35849 Burnout in a high heat-flux boiling system with an impinging jet. Monde, M.; Katto, Y. (Univ. of Tokyo). *Int. J. Heat Mass Transfer;* **21**: No. 3, 295-305(Mar 1978).

An experimental study has been made on the fully-developed nucleate boiling at atmospheric pressure in a simple forced-convection boiling system, which consists of a heated flat surface and a small, high-speed jet of water or of freon-113 impinging on the heated surface. A generalized correlation for burnout heat flux data, that is applied to either of water and freon-113, is successfully evolved, and it is shown that surface tension has an important role for the onset of burnout phenomenon, not only in the ordinary pool boiling, but also in the present boiling system with a forced flow.

35850 Thermal interaction for molten tin dropped into water. Arakeri, V.H.; Catton, I.; Kastenberg, W.E.; Plesset, M.S. (Univ. of California, Los Angeles). *Int. J. Heat Mass Transfer;* **21**: No. 3, 325-333(Mar 1978).

Multiflash photography with extremely short duration exposure times per flash was used to observe the interaction of molten tin dropped into a water bath. Detailed photographic evidence is presented which demonstrates that transition, or nucleate boiling, is a possible triggering mechanism for vapor explosions. It was also found that the thermal constraints required to produce vapor explosions could be relaxed by introducing a stable thermal stratification within the coolant. In the present work, the threshold value of the initial tin temperature required for vapor explosion was reduced from about 500 to 343°C.

35851 Two-dimensional void reconstruction by neutron transmission. Zakaib, G.D.; Harms, A.A.; Vlachopoulos, J. (McMaster Univ., Hamilton, Ontario). *Nucl. Sci. Eng.;* **65**: No. 1, 145-154(Jan 1978).

Contemporary algebraic reconstruction methods are utilized in investigating the two-dimensional void distribution in a water analog from neutron transmission measurements. It is sought to ultimately apply these techniques to the determination of time-averaged void distribution in two-phase flow systems as well as for potential usage in neutron radiography. Initially, projection data were obtained from a digitized model of a hypothetical two-phase representation and later from neutron beam traverses across a voided

methacrylate plastic model. From 10 to 15 views were incorporated, and decoupling of overlapped measurements was utilized to afford greater resolution. In general, the additive Algebraic Reconstruction Technique yielded the best reconstructions, with others showing promise for noisy data. Results indicate the need for some further development of the method in interpreting real data.

35852 Behaviour of liquid films and flooding in counter-current two-phase flow. I. Flow in circular tubes. Suzuki, S.; Ueda, T. (Univ of Tokyo, Bunkyo-Ku, Jpn). *Int. J. Multiphase Flow;* **3**: No. 6, 517-532(Dec 1977).

Experimental results are presented on the flooding gas velocity in tubes over a wide range of parameters--tube diameter, tube length, liquid flow rate, liquid viscosity and surface tension. The flooding phenomenon is caused by interaction between the waves on the liquid film and the upward gas stream. By measuring variation of the maximum height of the wavy liquid films with an increase of the gas flow rate, the complicated effects of tube length and surface tension on flooding are revealed. The data of the flooding velocity are empirically correlated in terms of nondimensional groups for each tube length.

35853 Influence of interfacial pressure forces on the character of two-phase flow model equations. Stuhmiller, J.H. (Jaycor, Del Mar, Calif). *Int. J. Multiphase Flow;* **3**: No. 6, 551-560(Dec 1977).

Equations for two-phase flow are developed where the interfacial pressure p/sub i/ is the closure variable. The assumption that p$sub i$ is constant leads to variations of the single pressure model with several aphysical properties. Use of more realistic pressure distributions, for flow about solid particles, produces a model displaying added mass and drag effects and having real characteristic roots. 11 refs.

35854 Model for slug frequency during gas-liquid flow in horizontal and near horizontal pipes. Taitel, Y.; Dukler, A.E. (Univ of Houston, Tex). *Int. J. Multiphase Flow;* **3**: No. 6, 585-596(Dec 1977).

When gas and liquid flow simultaneously in a pipe, various flow patterns may result. One of the most common of these is slug flow in which coherent plugs of aerated liquid are separated by regions of gas riding on a thin liquid film. Visual observations reveal that the slug is created as a result of unsteady waves formed on a growing stratified film which blocks the air passage. The entire phenomenon occurs near the entrance region and as such it can be classified as an entrance phenomenon in contrast to steady slug flow which has been shown to be independent of entry configuration. This process has been modeled and the results obtained are shown to be in agreement with experiment. 13 refs.

35855 Turbulent temperature fluctuations in liquid metals. Lawn, C.J. (Central Electricity Generating Board, Southampton, Eng.). *Int. J. Heat Mass Transfer;* **20**: No. 10, 1035-1043(Oct 1977).

Examination of experimental data for the spectral distribution of velocity (u and v) and temperature (theta) fluctuations in the fully turbulent region of heated pipe-flow has suggested a schematic representation which incorporates the essential features. Evidence is cited to suggest that the "-vtheta" correlation coefficient maintains higher values than the "uv" coefficient at wave-numbers in the inertial subrange. The theory of Batchelor, Howells and Townsend, and limited evidence from experiments in mercury, then suggests the form of the "theta^2" spectra and "-vtheta" cross-spectra in liquid metals. From this information, a limiting Peclet number is deduced, above which the correlation coefficient of v and theta should be a fairly weak function of Pe alone. An attempt to check this inference from published data for the rms level of temperature fluctuations, and for the turbulent Prandtl number, proves inconclusive, because many of the correlation coefficients so estimated have values greater than unity. It is concluded that all these results for anti theta must therefore be in error. However, since there is no evidence of very low correlation coefficients, they almost certainly lie in the range of 0.25 to 1 over a large proportion of the radius. This anti theta can be estimated for any fluid in which the fluctuations are induced by uniform heating, at least to within a factor of 2, using the analysis given.

35856 Fluid mechanics and resource development. Charles, M.E. (Univ. of Toronto). *Can. J. Chem. Eng.;* **55**: No. 4, 365-373(Aug 1977).

Novel fluid flow concepts have played important roles in the development of hydrocarbon and other resources. This has occurred frequently in such areas as mining and production, pipeline transportation and resource processing. Examples of interesting flow concepts drawn from experience with a wide variety of projects are discussed with the thought in mind that they may prove useful in the search for improved and new methods for the extraction of hydrocarbons from oil sands.

35857 Structure of steam-and-water projectile flow. Subbotin, V.I.; Pokhvalov, Yu.E.; Leonov, V.A. (Moscow Eng-Phys Inst, USSR). *Teploenergetika (Moscow);* No. 7, 65-67(Jul 1977). (In Russian).

In order to work out a resistive method of measurement of true steam content in a channel, it is necessary to know a number of time-dependent and structural characteristics of two-phase flow. Of particular interest is the projectile-type mode of flow. The structure of this type of flow is investigated in an 18 mm id tube at pressures from 1 to 7 MPa, circulation velocities of 0.3-2 m/s, mixture velocities of 0.3-6 m, and volumetric flow steam contents from 0 to 995. Conclusions are drawn regarding the principal carrier of information about the true steam content.

35858 Influence of the interconnection geometry on the diversion cross--flow between two parallel flows. Tapucu, A.; Troche, N. (Ec Polytech). pp 31-35 of Canadian Nuclear Association--annual international conference proceedings, 17, Volumes 1 through 6, 1977. Montreal; Canadian Nuclear Association (1977).

From 17. annual international conference of the Canadian Nuclear Association; Montreal, Ontario, Canada (5 Jun 1977).

This extended abstract describes an investigation of the influence of the interconnection geometry on the pressure-induced diversion cross-flow in reactor fuel bundles. Two different designs are presented and compared experimentally, and the influence of the interconnection geometry on the transverse resistance coefficient is derived.

35859 Problem of incipient nucleate boiling of liquids. Nadeev, A.T. *Therm. Eng. (USSR) (Engl. Transl.);* **23**: No. 7, 62-65(1976).

Translated from Teploenergetika; 23: No. 7, 72-74(1976).

At the present time the greatest interest is devoted to theoretical and experimental investigation of the physical conditions determining the boundaries of existence of the process of nucleate boiling of liquids. However, in view of the complexity of the boiling process many obscure problems remain. One such, in particular, is the mechanism of the incipience of boiling. Practically all the existing models satisfactorily describe the nature of incipient boiling only for two extreme cases: when the liquid well wets the heating surface and when the latter is poorly wetted. An experimental determination was made of the thermophysical conditions necessary for the incipience of nucleate boiling and their connection with certain properties of the liquid and the material of the heating surface.

MATERIALS TESTING

REFER ALSO TO CITATION(S) 34646, 35851

35860 Nondestructive testing of welds. Part II. Radiographic, sonic, and electrical techniques. Polentz, L.M. *Plant Eng. (Barrington, Ill.);* **32**: No. 7, 257-259(30 Mar 1978).

Nondestructive testing methods applicable to even deep welds are described and compared. These methods include x-ray and gamma-radiography, fluoroscopy, ultrasonic inspection, acoustic emission testing, and eddy current testing. (LCL)

ELECTRONIC CIRCUITS AND DEVICES

REFER ALSO TO CITATION(S) 34887, 34888

35861 Reducing the switching time of semiconductor devices by nuclear irradiation. Bartko, J.; Sun, K.H. (to Westinghouse Electric Corp.). US Patent 4,056,408. 1 Nov 1977. Filed date 17 Mar 1976. 28p.

A method of reducing the switching time of certain semiconductor devices and particularly gain-operated semiconductor devices is described. The depth of maximum defect generation in a given type of semiconductor devices having a block PN junction is determined on irradiation with a given radiation source emitting particles with molecular weight of at least one (1), preferably protons or alpha particles, and the energy level of the radiation source adjusted to provide the depth of maximum defect generation adjacent a blocking PN junction of the type of semiconductor device. At least one semiconductor device of said given type of semiconductor device is positioned with a major surface thereof to be exposed to the adjusted radiation source, and thereafter irradiated with the adjusted radiation source to a given dosage level to reduce the switching time of the semiconductor device. Preferably, the semiconductor device is positioned and the energy level of the radiation source adjusted to irradiate through the major surface of the device closer to the higher impurity region adjoining the blocking PN junction, and to provide the maximum defect generation in said higher impurity region adjoining the blocking PN junction but spaced from the PN junction beyond a depletion region formed at the PN junction on application of a specified blocking voltage across the PN junction of the semiconductor device.

35862 Distribution of magnetic field in magnetic system of slotless turbogenerator. Cheremisov, I.Ya.; Tenetko, N.I. *Sov. Electr. Eng. (Engl. Transl.);* **47**: No. 7, 24-30(1976).

A computational investigation is carried out for the distribution of magnetic induction in the magnetic system of a slotless two-pole turbogenerator in no-load regime; allowance is made for saturation of the stator-core material and magnetic-field displacement from the outside and inside core diameters.

COMBUSTION SYSTEMS

REFER ALSO TO CITATION(S) 34333, 34478, 34479, 34486, 34699, 34864, 34887, 34888, 34907, 35786, 35862

35863 Practical experience with reciprocating machines using natural gas. Helling, A. (Gasversorgung Sueddeutschland G.m.b.H., Stutensee (Germany, F.R.). Verdichteranlage Blankenloch). *Gas-Wasserfach, Gas-Erdgas;* **118**: No. 11, 498-503(Nov 1977). (In German).

This is in essential a practice-related report. After a general introduction to the main types of machines and compressor control, the basic criteria of gas motors are dealt with: ignition and combustion, lubricating oil and wear, cooling water. The article is based on knowledge gained in long experience with gas engines and compressors. The final part gives some recommendations concerning problems encountered.

35864 Fluidized bed process for the combustion of fuels of low calorific value. Raschka, A. *Aufbereit.-Tech.;* **18**: No. 10, 543-548(Oct 1977). (In German).

The paper highlights the characteristics of fluidized-bed firing systems for burning fuels of low calorific value. Moreover, it furnishes proof that the fluidized-bed process is an optimum method for burning low-caloric fuels, especially those containing great amounts of water and ash (such as sewage sludge). Seen from the point of view of process engineering, fuel of any water content can be fed into the furnace. The paper comments on the importance of the water content with regard to the efficiency of the firing system and autogenous combustion. An example comparing the cost of heat from a coal-fired boiler with that of a fluidized bed incinerator with low-caloric fuel demonstrates the economic advantages. The paper reports on a large-scale test in which flotation tailings were burned in an industrial-scale fluidized-bed combustion system. 2 refs.

35865 Testing an automatic fuel oil burner control system. Khesin, M.Ya.; Astashkin, E.I.; Anisyaev, E.M.; Uvarov, L.A. (All-Union Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 8, 22-26(Aug 1977). (In Russian).

Results of tests of the experimental model of an automatic fuel oil burner control system of a PK-41 boiler and recommendations on the necessary improvements and introduction of this system into service are presented. At the same time, results of comparative tests of several methods of control of the presence of the flame of the main burner under different conditions of operation by the boiler are obtained.

35866 Investigation of the aerodynamics and combustion process in the furnace chamber of a tpp-312a boiler. Shnitser, I.N.; Yur'ev, L.V.; Solov'ev, L.K.; Litovkin, V.V. (Cent Sci Res Boiler and Turbine Inst, USSR). *Teploenergetika (Moscow);* No. 7, 32-37(Jul 1977). (In Russian).

Results of investigations of the aerodynamic structure of the burning fuel spray and the process of combustion in the furnace chamber of a single-shell TPP-312A boiler with the steam output of 364 kg/s, equipped with burners having the thermal capacity of 100 MW, are presented. It is found expedient to reduce the intensity of the burner swirl for burning high-reactivity coal grades, such as the Donbas gaseous coal siftings. This is accomplished by replacing the volute chamber with direct-flow introduction of the pulverized fuel/air mixture.

35867 Preliminary results of adjustment and research work on a gas and residual oil-fired boiler with bottom layout of burners. Andronov, A.A.; Voloshin, V.M.; Durmanov, E.G.; Kovalenko, A.L.; Kozlov, V.G.; Kulikov, A.A.; Libenko, K.P.; Motro, I.Ya.; Savin, A.M.; Shichko, V.N. (Heat and Electr Power Plant, Ul'yanovsk, USSR). *Teploenergetika (Moscow);* No. 7, 38-42(Jul 1977). (In Russian).

Results of tests of a boiler equipped with bottom burners, one of the first boilers of this type in the USSR, are presented. The extent of fuel burnout along the flame torch is determined. The possibility of controlling the fluxes over the height of the fire-chamber is demonstrated.

35868 Effect of controlling factors of double-flow reversible burners on integral flow swirl. Akhmedov, R.B.; Magdeev, A.M. *Teploenergetika (Moscow);* No. 7, 42-44(Jul 1977). (In Russian).

The extent of the influence of the design and operating mode factors of a double-flow reversible burner equipped with axial swirlers on the value of the integral flow twist parameter θ and the establishment of relations between this parameter and the main characteristics of the twisted flow is determined. A diagram of the device and of its connection to an aerodynamic setup is presented. A mathematical model is obtained for the integral flow twist parameter. The integral twist parameter θ reflects the effect of all the main factors influencing the twisting capacities of the flame. The effect of the intensity of the peripheral flow twist is decisive.

35869 Investigation of ash contamination of the ceramic packing of regenerative air preheaters of residual oil-fired boilers. Madoyan, L.G.; Monarkhovich, A.N.; Koinov, G.V.; Gadyak, V.A.; Kruk, M.T.; Kapeliovich, A.M. (State Reg Electric Power Plant, USSR). *Teploenergetika (Moscow);* No. 7, 45-47(Jul 1977). (In Russian).

The character of ash deposition on a test batch of tubular ceramic packing installed as a cold layer in the top parts of three regenerative air preheaters RVP-54 in a TGM--94 boiler (above two layers of hot metallic packing) is investigated. The packing elements are made of hard porcelain coated with acid-resisting glaze. It is found that, as a result, the character of ash deposits in regenerative air preheaters changes. Low-temperature deposits are formed from fly ash, products of mechanical fuel underfiring, and condensing sulfuric acid. The total volume of deposits is lower than on the metallic packing because metal corrosion products are absent. As a result, the ratio between the components does not change. However, there is some increase in toxic particulate emissions into the atmosphere.

35870 Technology of kindling with frequent startups of drum-type boilers. Moseev, G.I.; Tugov, A.I. (All-union Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 7, 47-51(Jul 1977). (In Russian).

It is shown that considerable sign-variable flowrate fluctuations arise in the circulation loops of drum-type boilers with natural circulation at the initial stage of kindling. As a result, sharp and dangerous temperature fluctuations arise in the lower collectors and in the apertures for the downcoming drum pipes. Various measures to reduce temperature fluctuations and stresses in the drum and lower collectors are recommended. In particular it is recommended to begin boiler firing from upper tie burners. 9 refs.

35871 Two-channel automatic fuel/air consumption ratio control systems for gas and oil-fired boilers. Kasimzade, M.S.; Khasmamedov, T.I.; Panov, Yu.s. (AzNIIE, USSR). *Teploenergetika (Moscow);* No. 7, 51-54(Jul 1977). (In Russian).

Block diagrams of two new fuel/air ratio control systems are presented. In these systems, the fuel/air consumption ratio error is dealt with by two combustion control channels. The tests of the new systems carried out on a laboratory setup and on an industrial boiler are described. The new systems reduce the dynamic discrepancy between fuel and air consumption ratios and thus improve the efficiency of the combustion process.

35872 Algorithm of functioning of the automatic raw coal bunker charging system. Feofilov, G.P.; Konovalov, I.V.; Paroder, S.Sh. (All-Union Heat Eng Inst, USSR). *Teploenergetika (Moscow);* No. 7, 55-58(Jul 1977). (In Russian).

An attempt is made to formulate the algorithm of functioning of an automatic system of charging raw coal bunkers. This system has been developed by the Urals Thermal Engineering Institute for the Barnaul No. 2 heat and power plant.

35873 Toroidal engine. Biedermann, P. German(FRG) Patent 2,541,152/A/. 24 Mar 1977. 9p. (In German).

A toroidal engine is described. The engine is characterised by pistons, which rotate or oscillate in a toroid and are fixed to a disc, whose periphery closes the toroid, except for the part which is cut out. Energy is introduced via a duct fitted into the axis. The piston is used as an additional stroke volume. Steam, gas or normal engine fuels are suitable as fuels.

35874 Effect of burnout dynamics on gas temperature distribution in fire chambers. Reznik, O.A. (Cent Boiler and Turbine Inst, USSR). *Energomashinostroenie;* No. 8, 8-9(1977). (In Russian).

A method of analytical determination of the temperature of furnace gases and heat fluxes in the furnace chamber is proposed. It is based on a zone-by-zone calculation of heat transfer and on the diffusion-kinetic theory of burnout of an isothermal polydispersed fuel spray in chamber-type furnaces.

35875 Effect of burner design and of their layout on the ignition of pulverized kuznetsk coal varieties. Bondarev, A.M. (State Reg Electr Power Plant, USSR). *Energomashinostroenie;* No. 8, 31-33(1977). (In Russian).

Specific features of ignition and supposed causes of different effectiveness of ignition of burner fuel sprays arranged in a row are considered. Heat fluxes incident on the p.f. jet discharged from burners are studied by direct two-way thermal probes in PK-40-200MW and TP-10 50MW boilers. Results of tests show that radiant

heat plays a considerable role in the heating and ignition of the p.f. spray when burning oxidized Kuznetsk coal varieties. It is recommended to increase the burner capacities when designing fire chambers for burning low-reactivity coal, in order to increase absolute distance between them while lowering their number.

POLLUTION CONTROL EQUIPMENT

REFER ALSO TO CITATION(S) 34917, 34918, 34920, 34921, 34926, 34930, 34934, 34935, 34936, 34937, 34939, 35494

35876 Method of reducing NO/sub x/ present in an exhaust to harmless N_2. Moriguchi, S.; Abe, H.; Takenaka, J.; Yoshikoshi, H.; Komatsu, O. (to Nippon Kokan Kabushiki Kaisha). US Patent 4,070,440. 24 Jan 1978. Priority date 5 Sep 1975, Japan. 8p.

A method for reducing NO/sub x/ gas contained in an exhaust gas to harmless N_2 gas with NH_3 gas using an iron oxide catalyst is described. The iron oxide catalyst comprises a substance consisting essentially of hematite crystals (α-Fe_2-O_3), and the peak intensity of X-rays diffracted on the (110) plane of the lattice of said crystal has a ratio of 0.6 to about 1.0 to that of X-rays diffracted on the (104) plane of said crystal lattice.

35877 Two-phase flow through fractures in porous media. Ryan, J.T.; Neale, G. (Univ. of Ottawa). *Can. J. Chem. Eng.;* **55**: No. 4, 471-472(Aug 1977).

The flow of fluids through slits in porous media is of great interest in both theory and practice, especially in relation to oil recovery displacement operations. One theoretical aspect of the problem, namely the cocurrent stratified laminar flow of two immiscible Newtonian liquids through a two-dimensional channel bounded on both sides by a porous medium of absolute permeability k, is examined.

35878 Developments in sulfur dioxide control. Campbell, I.E. (Smelter Control Research Association, Inc., Columbus). pp 817-824 of World mining and metals technology. Volume II. Weiss, A. (ed.). New York; American Inst. of Mining, Metallurgical, and Petroleum Engineers, Inc. (1976).

From Proceedings of the joint MMIJ-AIME meeting; Denver, CO, USA (1 Sep 1976).

See CONF-7609165—P2.

Activities of the Smelter Control Research Association in investigating processes for removal of sulfur oxides and particulates from copper reverberatory furnace stack gases are reported. Wet limestone and ammonia scrubbers were evaluated. A 4000 CFM ammonia double-alkali process pilot plant was constructed, and its operation showed that very high SO_2 recovery efficiencies are attainable. The disadvantages of this system are high energy and materials requirements and the generation of large tonnages of sludge that must be disposed of. (LCL)

POWER CYCLES

RANKINE

35879 Cascaded two-fluid rotary closed rankine cycle engine. Doerner, W.A.; Van Buskirk, O.R. (to E.I. du Pont de Nemours and Co.). US Patent 4,070,862. 31 Jan 1978. Filed date 24 Sep 1976. 16p.

A cascaded, two-fluid, rotary Rankine cycle engine is provided having improved efficiency and being capable of operating with a power fluid which is solid at ambient temperature. The engine comprises a rotatable annular boiler containing a first boiler liquid and means to heat this first boiler liquid to generate pressure vapor in the boiler, an expander system for extracting work from the vapor, an annular condenser rotatable with the boiler for condensing the exhaust vapor from the expander, the condenser having heat exchange tubes over which the exhaust vapor is passed to heat a second liquid contained in the tubes to generate pressure vapor therein, the second liquid having a lower boiling point than the first liquid, means for returning the vapor condensate to the boiler, a second expander system for extracting work from the pressure vapor in the heat-exchanging tubes, a rotatable second condenser for condensing the eexhaust vapor from the second expander, and means for returning the vapor condensate from the second condenser to the heat-exchange tubes.

OTHER

35880 Efficiency of the solid-state engine made with Nitinol memory material. Golestaneh, A.A. (Materials Science Division, Argonne National Laboratory, Argonne, Illinois 60439). *J. Appl. Phys.;* **49**: No. 3, 1241-1244(Mar 1978).

The thermal efficiency of the solid-state engine (SSE) based on the shape-recovery phenomenon accompanied by the martensite-parent-phase (M→P) transformation has been evaluated. Particular application is made for the memory components made with the Nitinol alloys. The result is expressed in terms of the hot and cold reservoir temperatures (T and T_0), the latent heat of the M→P transformation, ΔH, the fraction of the M→P transformation, α, and a coefficient β that depends on the geometry and type of the deformation of the memory component. The relationship between the efficiencies of the SS and the Carnot engines is discussed. The factor α is expressed in terms of T/sub c/, the critical temperature under an applied load, the degree of prestraining of the component, and the volume change involved in the M→P transformation. It is seen that the maximum of the thermal efficiency approaches that of the Carnot engine at an $x=T-T_0$ value that depends on T_0, ΔH, and α. Choosing $T_0=297$ K and a Nitinol alloy with $\Delta H=2$ cal/g, the maximum efficiency, about 20%, occurs at x=75 K. Moreover, for a steady-state heat-mechanical energy conversion, the critical temperature of the memory component is found in terms of the T and T_0 temperatures. The engine efficiency in terms of the energy loss due to friction and the heat-transfer coefficient is analyzed and estimated to be about 16%.It is seen that higher thermal efficiency can be obtained if a Nitinol alloy with a larger H value than given above can be found.

PARTICLE ACCELERATORS

DESIGN, DEVELOPMENT, AND OPERATION

35881 Apparatus for the acceleration of ions in the virtual cathode of an intense relativistic electron beam. Miller, R.B. (to Secretary of the Air Force). US Patent 4,070,595. 24 Jan 1978. Filed date 8 Dec 1976. 4p.

The acceleration of large numbers of ions to high energies uses an intense relativistic electron beam produced by a vacuum diode. An electron beam radial profile is maintained by a strong longitudinal magnetic field. A virtual cathode, characterized by an electrostatic potential depression whose depth corresponds to the injected electron beam kinetic energy will form. The virtual cathode is caused to move backwards toward the vacuum diode by utilizing the time history of the injected electron beam voltage and current, and by appropriately flaring the drift tube. Ions trapped in the potential well associated with the virtual cathode move with the virtual cathode and are synchronously accelerated.

BEAM DYNAMICS, FIELD CALCULATIONS, AND ION OPTICS

35882 Influence of chromatic aberrations on space charge ion optics. Whealton, J.H.; Tsai, C.C. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Rev. Sci. Instrum.;* **49**: No. 4, 495-498(Apr 1978).

By solution to the Poisson-Vlasov equation the influence of fluctuations (chromatic aberrations) on ion optics is shown for various accelerator designs : (1) cylindrical bore triode with various aspect ratios, (2) pseudo-Pierce shaped electrode triode at various aspect ratios, (3) insulated coating emission electrode triode for various preacceleration potentials, and (4) cylindrical bore tetrodes for various field distributions. Fluctuation levels of 20% can be very important in limiting the ion optics in certain cases.

35883 Numerical simulation of autoresonant ion acceleration. Godfrey, B.B. (Los Alamos Scientific Lab., NM). *IEEE Trans. Plasma Sci.;* **PS-5**: No. 4, 223-230(Dec 1977).

Computational and analytic studies of the Autoresonant Acceleration proposal for collective ion acceleration are presented. Linear theory is reviewed, the electrostatic well depth is estimated nonlinearly, and an electron beam envelope equation is derived and solved. Two-dimensional numerical simulation results are given. Together, these calculations demonstrate unneutralized electron beam equilibrium in a diverging magnetic guide field, the behavior of large amplitude slow cyclotron waves in the beam, and the acceleration of test ions over short distances in the wave troughs. In addition, the computer simulations point up the need for improved understanding of the linear theory of radially inhomogeneous nonneutral beams and for methods of suppressing radial modulation at the diode-waveguide interface.

AUXILIARIES AND COMPONENTS

35884 Method of enhancing cyclotron beam intensity. Hudson, E.D.; Mallory, M.L. (to Energy Research and Development Admin-

istration). US Patent 4,055,782. 25 Oct 1977. Filed date 22 Apr 1977. 4p.

PAT-APPL-789,765.

When an easily ionized support gas such as xenon is added to the cold cathode in sources of the Oak Ridge Isochronous Cyclotron, large beam enhancements are produced. For example, $^{20}Ne^{7+}$ is increased from 0.05 enA to 27 enA, and $^{16}O^{5+}$ intensities in excess of 35 eμA were extracted for periods up to 30 minutes. Approximately 0.15 cc/min of the easily ionized support gas is supplied to the ion source through a separate gas feed line and the primary gas flow is reduced by about 30%.

35885 **Magnetic analyzer for a compact cyclotron.** Basargin, Y.G.; Gal'chuk, A.V.; Korolev, L.E.; Levchenko, V.G.; Pavlov, G.M.; Popov, A.V.; Stepanov, A.V. (D. V. Efremov Scientific-Research Institute of Electrophysical Apparatus). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 9, 1104-1106(Sep 1977).

An analyzing magnet intended for magnetic analysis of the cyclotron beam of a compact cyclotron has been designed and constructed. The analyzer uses a magnet with a homogeneous field. The beam resolution can be raised to $\Delta E/E = 10^{-3}$ (FWHM).

STORAGE RINGS

35886 (BNL—50701) **Prospects for strong interaction physics at ISABELLE.** Sidhu, D.P.; Trueman, T.L. (Brookhaven National Lab., Upton, N.Y. (USA)). 1977. Contract EY-76-C-02-0016. 227p. (CONF-770338—). Dep. NTIS, PC A11/MF A01.

From Isabelle workshop; Upton, NY, USA (30 Mar 1977).

Seven papers are presented resulting from a conference intended to stimulate thinking about how ISABELLE could be used for studying strong interactions. A separate abstract was prepared for each paper for inclusion in DOE Energy Research Abstracts (ERA). (PMA)

35887 (BNL—50701, pp 47-60) **Behavior of proton—proton total cross section up to 50 TeV.** Yodh, G.B. (Univ. of Maryland). 1977.

From Isabelle workshop; Upton, NY, USA (30 Mar 1977).

In Prospects for strong interaction physics at ISABELLE.

From cosmic ray data on proton-air inelastic cross sections up to 50 TeV, proton-proton total cross sections are estimated using Glauber formalism to relate p-p parameters to p-air cross sections. Proton-proton total cross sections are found to be greater than 53 mb at 47.6 TeV.

35888 (BNL—50701, pp 61-84) **Diffractive processes at ISABELLE.** Pumplin, J. (Michigan State Univ., East Lansing). 1977.

From Isabelle workshop; Upton, NY, USA (30 Mar 1977).

In Prospects for strong interaction physics at ISABELLE.

The proposed colliding beams accelerator ISABELLE will enable one to study proton-proton interactions at energies up to s approximately 2 x 10^5 GeV^2, with a luminosity approximately 10^{33}/cm^2 sec. A discussion is given of the study of diffractive processes in strong interactions as a guide to the basic issues in diffraction scattering, from the viewpoint of present-day theory. Theoretical concepts and the phenomenology of diffractive processes are reviewed.

35889 (BNL—50701, pp 85-108) **Interactions of cosmic ray hadrons from 10^4 to 10^6 GeV.** Gaisser, T.K. (Bartol Research Foundation of The Franklin Inst., Swarthmore, PA). 1977.

From Isabelle workshop; Upton, NY, USA (30 Mar 1977).

In Prospects for strong interaction physics at ISABELLE.

Three topics from the field of high energy cosmic rays that are relevant to properties of hadronic interactions at energies not accessible to existing accelerators are discussed. In each case, the implications for future experiments at ISABELLE and other accelerators planned to probe the energy range of E/sub Lab/ approximately 10^4 GeV and beyond are evaluated. A systematic analysis of inclusive distributions of photons produced in collisions of hadrons with light nuclei is given. The overall conclusion is that, although the data is consistent with scaling for small x in the fragmentation region, the plateau appears to rise significantly beyond ISR energies with a correspondingly rapid increase in multiplicity. The situation in the more controversial field of high p/sub T/ in cosmic rays is summarized. If the suggestions of some experiments are correct, then the high p/sub T/ component of hadronic interactions must become much more important relative to the normal component for E/sub Lab/ > 10^4 GeV than would be expected by extrapolating accelerator data on high p/sub T/ using fits of the form p/sub T/$^{-8}$. Some analyses of atmospheric cascades produced by interactions of cosmic rays of E ≧ 10^6 GeV are briefly reviewed. The interpretation of these experiments is ambiguous because the primary composition of cosmic rays is unknown at these energies. It is, however, possible to draw conclusions corresponding to various assumptions about the primary composition.

35890 (BNL—50701, pp 109-140) **Unusual interactions above 100 TeV: a review of cosmic ray experiments with emulsion chambers.** Yodh, G.B. (Univ. of Maryland, College Park). 1977.

From Isabelle workshop; Upton, NY, USA (30 Mar 1977).

In Prospects for strong interaction physics at ISABELLE.

It is difficult to interpret cosmic ray hadronic interactions because the experiments only observe the products subsequent to an interaction (or interactions) and because the nature of the primary is not known. There are two observations which are most unusual; these are: (1) possible existence of "π^0" less events of high multiplicity; and (2) events with very large multiplicity. The purpose of the work presented is to examine the techniques, describe the unusual events, answer te question "are there normal events." and estimate the rate for such events. It is argued that the number of events being observed by these emulsion chamber experiments are consistent with the expected number, hence these experiments are not singling out only exceptional events but rather represent a reasonable sample of interactions above 100 TeV. It is likely that one is observing new phenomena which could be accessible at ISABELLE energies for controlled studies. It is hoped that this survey may provide guidance in the design of future experimental facilities at ISABELLE.

35891 (BNL—50701, pp 141-176) **Multiparticle correlations: prospects for ISABELLE.** Ludlam, T. (Yale Univ., New Haven). 1977.

From Isabelle workshop; Upton, NY, USA (30 Mar 1977).

In Prospects for strong interaction physics at ISABELLE.

Exploring the systematics of hadron production in many-body final states is essential to an experimental program whose aim is to address the nature of strong interaction processes (broadly, the term multiparticle correlations includes such investigations). Historically, a great deal of effort has gone into these exporations for as long as high energy collision data have been available for study, and considerable physics insight has been gained despite the enormous kinematic complexity of the typical inelastic collision. Progress has been made by summing over most of the complications and investigating those features which appear to be most revealing and amenable to theoretical interpretation. The connection with theory is through phenomenological constructions which embody the ingredients of theories and are parameterized in terms of the measured properties of simpler processes. At ISABELLE, these pursuits will be part of a larger program in which we expect to examine directly fundamental processes about which we have thus far only speculated. Present models cannot be simply extrapolated as a reliable guide to the most interesting aspects of multiparticle data at the new energies. A discussion is given of some aspects of multiparticle analysis and recent experimental data which seem to be of particular importance in the consideration of new investigations at ISABELLE. The discussion includes some consideration of detection capability, emphasizing the need among the first experiments for accurate measurements of charged particle production over the full solid angle and assuming the eventual presence of very sophisticated multiparticle spectrometer facilities.

35892 (CONF-770753—, pp 374-377) **Antiproton: proton collisions in ISABELLE.** Baltay, C. (Columbia Univ., New York). 18 Jul 1977.

From Isabelle workshop; Upton, NY, USA (18 Jul 1977).

In Proceedings of the 1977 Isabelle Summer Workshop.

A scheme for producing antiproton—proton collisions is discussed and reconsidered for the new 400 GeV design of ISABELLE. The antiproton filling time is estimated, and the possibility of increasing beam luminosity using stochastic cooling is discussed. (PMA)

35893 (CONF-770753—, pp 399-421) **ep possibility for ISABELLE.** Wilson, R. (Harvard Univ., Boston). 18 Jul 1977.

From Isabelle workshop; Upton, NY, USA (18 Jul 1977).

In Proceedings of the 1977 Isabelle Summer Workshop.

The feasibility of adding an electron ring to ISABELLE is discussed in terms of cost, physics goals, count rate estimates, the detector requirements, and the possibility of producing intermediate bosons. The purpose of adding an electron ring to ISABELLE must be considered to be the study of $e^+ p \to e^+ x$, $e^- p \to \nu x$, and $e^+ p \to$ anti νx. Other processes, such as W production, are less interesting for an ep ring than for a pp ring. However, there may be other new particles--such as leptonic quarks--that only turn up here. These processes are, however, exciting. In a 30 day run at $L = 10^{32}$ cm^{-2} sec^{-1} 300 neutrino events are expected at $q^2 > 5000$ GeV^2 where the propagator is expected to be less than 1/4. Thus the value of the mass in the propagator can be measured to 5%. The ep cross section would be measured over the momentum transfer range $1 < q^2 < 5000$ (GeV/c^2). This range is large enough that a logarithmic deviation from scaling can be distinguished easily from a power law approach to scaling.

35894 (CONF-770753—, pp 421-422) **What good is the muon storage option.** Wilson, R. (Harvard Univ., Boston). 18 Jul 1977.

From Isabelle workshop; Upton, NY, USA (18 Jul 1977).

In Proceedings of the 1977 Isabelle Summer Workshop.

A brief discussion is given of the value of providing for muon storage at ISABELLE. It is concluded that ISABELLE would not make the ideal storage ring and that a better ring has been suggested for Fermilab. (PMA)

35895 (SLAC-PUB—2013) **Standard Wiggler magnets.** Winick, H.; Helm, R.H. (Stanford Univ., Calif. (USA). Stanford Synchrotron Radiation Lab.; Stanford Linear Accelerator Center, Calif. (USA)). Sep 1977. Contract EY-76-S-03-0326. 19p. (CONF-770988—4). Dep. NTIS, PC A02/MF A01.

From Conference on synchrotron radiation instrumentation; Orsay, France (15 Sep 1977).

Interest in Wiggler magnets (a close sequence of transverse fields with alternating polarity) to extend and enhance the spectrum of synchrotron radiation from electron storage rings has increased significantly during the past few years. Standard wigglers, i.e., wigglers in which interference effects on the spectrum of synchrotron radiation are not important, are considered. In standard wigglers the spectrum of synchrotron radiation has the same general shape as the spectrum from ring bending magnets. However, the critical energy of the wiggler spectrum may be different. The critical energy of the wiggler spectrum is given by epsilon/sub CW/ = epsilon/sub CB/(B/sub W//B/sub B/) where epsilon/sub CB/ is the critical energy from the bending magnets and B/sub W/ and B/sub B/ are the magnetic field strengths of the wiggler magnet and bending magnets respectively. Since most electron storage rings operate with relatively low bending magnet fields (B/sub B/ less than or equal to 12 kG), even a modest wiggler magnet field (less than or equal to 18 kG) can significantly increase the critical energy. Such magnets are planned for ADONE and SPEAR. Higher field (30 to 50 kG) superconducting magnets are planned at Brookhaven, Daresbury, and Novosibirsk to produce even larger increase in the critical energy. For some standard wigglers a further enhancement of the spectrum is produced due tothe superposition of the radiation from the individual poles. Wiggler designs are discussed as well as the effect of wigglers on the synchrotron radiation spectrum and on the operation of storage rings.

INSTRUMENTATION

RADIATION INSTRUMENTATION

GENERAL DETECTORS AND MONITORS

REFER ALSO TO CITATION(S) 34564, 35040, 36068, 36086

35896 (LA-UR—78-48) **Two new portable survey instruments: the field phoswich detector and the Wee Pee Pee.** Umbarger, C.J.; Wolf, M.A. (Los Alamos Scientific Lab., N.Mex. (USA)). 1978. Contract W-7405-ENG-36. 20p. (CONF-780110—9). Dep. NTIS, PC A02/MF A01.

From 11. symposium on radiation instrumentation; San Diego, CA, USA (17 Jan 1978).

As part of a continuing program to upgrade the health physics survey instrumentation at Los Alamos, we have recently developed two new portable instruments. The first is a fully portable phoswich detector for low energy photons from small amounts of plutonium and americium in the field. The instrument has a background that is 2 to 3 times lower than an equivalent thin NaI detector. The instrument features an aural popper, analogue rate meter, and timer/scaler with liquid crystal display. The second instrument, called the "Wee Pee Wee," is an alpha air proportional probe with complete electronics and readout package mounted on the probe itself. The entire package has a mass of 0.66 kg (1.45 lb) and is carried and operated in one hand. For monitoring shoes and other places where it is difficult to read the count-rate meter, the meter is made detachable for clipping to a shirt pocket, etc. An audio popper, range scales to 100 K cpm, and visual checks for high voltage and battery levels are also included.

35897 **Focussed radiographic camera.** Wilson, D.T. (to Raytheon Co.). US Patent 4,068,126. 10 Jan 1978. Filed date 22 Nov 1976. 6p.

A radiographic camera of the form employing a scintillator for producing optical photons in response to incident gamma and x-radiation is described. A collimator is positioned between a subject emitting such radiation and the scintillator for guiding the radiation to the scintillator and a detector of optical photons for signaling the positions of points of impingement of quanta of the incident radiation upon the scintillator to produce an image of the subject. A Fresnel focussing means is located alongside the scintillator for directing the optical photons to the detector. The Fresnel focussing means takes the form of a segmented mirror at the front surface of the scintillator and a Fresnel lens at the back surface of the scintillator.

35898 **Method and apparatus for determining accuracy of radiation measurements made in the presence of background radiation.** Horrocks, D.L. (to Beckman Instruments, Inc.). US Patent 4,059,762. 22 Nov 1977. Filed date 17 May 1976. 10p.

A radioactivity measuring instrument, and a method related to its use, for determining the radioactivity of a sample measured in the presence of significant background radiation, and for determining an error value relating to a specific probability of accuracy of the result are presented. Error values relating to the measurement of background radiation alone, and to the measurement of sample radiation and background radiation together, are combined to produce a true error value relating to the sample radiation alone.

35899 **Collimator trans-axial tomographic scintillation camera.** Jaszczak, R.J. US Patent 4,057,726. 8 Nov 1977. Filed date 22 Dec 1975. 8p.

A collimator is provided for a scintillation camera system in which a detector precesses in an orbit about a patient. The collimator is designed to have high resolution and lower sensitivity with respect to radiation traveling in paths laying wholly within planes perpendicular to the cranial-caudal axis of the patient. The collimator has high sensitivity and lower resolution to radiation traveling in other planes. Variances in resolution and sensitivity are achieved by altering the length, spacing or thickness of the septa of the collimator.

35900 **Positron imaging system with improved count rate and tomographic capability.** Muehllehner, G.; Buchin, M.P. (to G.D. Searle and Co.). US Patent 4,057,727. 8 Nov 1977. Filed date 22 Oct 1976. 10p.

A positron imaging system and method in which two opposed Anger cameras are employed on opposite sides of an organ to be imaged are described. The cameras include a planar unitary scintillation crystal approximately one inch in thickness, and the electronics which process the signals from the cameras include pulse shaping circuitry to reduce both the duration and the integration time of pulses resulting from radioactive events. Both cameras exclude collimators to enable radiation incident upon them at many angles to be accepted, and means are included to rotate the opposed cameras about the organ of interest to enable transverse tomographic imaging.

35901 **Calibration of a dePangher long counter from 2 keV to 19 MeV.** Slaughter, D.R.; Rueppel, D.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). *Nucl. Instrum. Methods;* **145**: No. 2, 315-320(1 Sep 1977).

The authors have measured the sensitivity of a dePangher precision long counter (PLC) relative to ^{7}Li(p,n), T(p,n), and T(d,n) differential cross sections over the neutron energy range 10 keV-19 MeV. Absolute sensitivity at 2 keV is also measured, using a scandium filtered beam at a reactor. Results obtained with errors in the range 5-30% are consistent with the assumption of a nearly constant sensitivity over the range 2 keV-6 MeV, but exhibit a reduction above 12 MeV.

35902 **Method and system for improving the definition of a scintillation detector.** Wilson, J.B. (to Georgetown Univ.). US Patent 4,044,261. 23 Aug 1977. Filed date 17 Mar 1976. 6p.

The definition of a tomographic readout image is highly sharpened and improved by minimizing or eliminating the effects of persisting images in the electronic scintillating circuit resulting from phosphorescent afterglow, by utilizing a special filter network in the detecting circuit.

RADIATION DOSEMETERS

REFER ALSO TO CITATION(S) 36029, 36063, 36094

35903 **Thermoluminescent beta dosimetry for routine personnel monitoring.** Benko, L.; Uchrin, Gy.; Biro, T. (Magyar Tudomanyos Akademia Izotop Intezete, Budapest). pp 1261-1264 of Proceedings of the 4. International congress of the International Radiation Protection Association. Paris, 24-30 April 1977. Vol. 4. Fontenay-aux-Roses, France; Association Internationale de Protection contre les Rayonnements (1977).

From 4. congress of the International Radiation Protection Agency; Paris, France (24 Apr 1977).

See CONF-770409—.

Different types of thermoluminescent materials (LiF, $CaSO_4$:Dy, $CaSO_4$:Tm) with different shapes and thicknesses were tested in order to select dosemeters for beta skin dose measurement. Sensitivity and energy response have been determined for a wide range of beta (0.225 to 2MeV) and gamma energy (0.01 to 1.33 MeV). The directional response was measured with different types of holders developed for a routine flexible personnel dosimetry. The properties and possible applications of a 5 to 15 mg cm^{-2} thick phosphor/heat-resistant resin dosemeter using fine LiF and $CaSO_4$:Dy powder and Al disc as holder is reviewed. Phantom

measurements, using mixed beta and gamma radiations, demonstrate the performance of the finger dosimetry system.

35904 Gamma-ray scintillation detector. Tatsuta, H.; Kumazawa, S. (to Japan Atomic Energy Research Inst.). US Patent 4,059,765. 22 Nov 1977. Priority date 24 Apr 1975, Japan. 4p.

A plurality of independent scintillators are used to measure radiation dose rate. The opening of a light shielding shutter locating the scintillators and a photomultiplier is adjusted to maintain linear proportional relationship between the counting rate and the dose rate.

35905 Electronic instrument for radon daughter dosimetry. Durkin, J. Washington, DC; Bureau of Mines (1977). 22p.

Owing to the daily exposures of uranium mining personnel to ^{222}Rn daughters, a device is needed that will continually monitor individual exposure. Such a device has been built and tested by the Bureau of Mines and is known as a radon daughter dosimeter. This is an electronic instrument using a solid-state detector and circuitry. The concept of the instrument, which is a personal device worn throughout the working shift, is to evaluate an individual's cumulative exposure to airborne radon progeny, expressed in units of working level hours. Since the instrument is in close proximity to the miner and measures continual exposure, it avoids the errors caused by the present technique of spot checking of the environment and provides a more accurate account of total cumulative exposure. 9 refs.

NUCLEAR SPECTROSCOPIC INSTRUMENTATION

35906 (UCRL-Trans—11330) **Certain characteristics of the stabilization system of a gamma-ray spectrometer with a light-emitting diode as the source of the reference signal.** Bakhterev, V.V.; Bausov, A.V.; Zyryanov, L.A.; Sen'ko-Bulatnyi, I.N.; Shindel'man, A.V. Feb 1978. Translated from pp 58-63 of Yaderno-geofizicheskie issledovaniya, Akad. Nauk SSSR, Ural. Nauchn. Tsentr, Sverdlovsk, USSR, 1975. 9p. Dep. NTIS, PC A02/MF A01.

A downhole gamma-ray spectrometer with reference stabilization has been designed at the Institute of Geophysics of the Ural Science Center of the USSR Academy of Sciences. Some results of the experimental operation of the instrument are presented.

RADIOMETRIC INSTRUMENTS

REFER ALSO TO CITATION(S) 35920

35907 Method of determining the water equivalent depth of snowfall using neutrons of cosmic rays. Wada, M.; Kodama, M.; Kawasaki, S. (to Rikagaku Kenkyusho). US Patent 4,047042. 6 Sep 1977. Priority date 15 Jun 1974, Japan. 4p.

A method is described for determining the depth of an accumulation of snow in which the water-equivalent depth of the accumulation of snow is determined from the count of survival neutrons of cosmic rays after passing through the accumulation of snow.

RADIATION EFFECTS ON INSTRUMENT COMPONENTS, INSTRUMENTS, OR ELECTRONIC SYSTEMS

REFER ALSO TO CITATION(S) 35861

35908 (PEM—61) **Shielding and grounding topology for interference control.** Vance, E.F. (Stanford Research Inst., Menlo Park, Calif. (USA)). Aug 1977. Contract W-7405-ENG-48-EC-301. 19p. Dep. NTIS, PC A02/MF A01.

The topological approach to shielding and grounding is a rational and systematic method of providing the high degree of isolation required between external conductors exposed to lightning or other harsh environments and small-signal circuits susceptible to transients of a few volts. Topologically, grounding has no effect on externally-generated interference serving only to equalize the potentials of otherwise insulated metal parts within a shield. It helps control spurious potentials generated by sources inside the shielded region. The topology of shielding and grounding dictates that grounding conductors should not penetrate shield surfaces. The circuit upset and damage problems associated with the common practice of connecting small-signal ground to the building electrical ground electrode are readily understood from the topological picture. Any natural shielding that might have been provided by the building or equipment cabinet has been circumvented by the grounding conductor, thereby exposing the small-signal circuits to the harsh outside environment. An advantage of the shielding and grounding philosophy is that system performance is completely independent of the grounding electrode impedance. The properties of the grounding electrode can therefore be left to the discretion of power and communication utilities. The single-entry concept alleviates the requirement for a high-quality overall shield if the principal source of interference is large currents on outside conductors such as power lines and communication cables. The essence of the approach and its principal advantage is that it provides a rational method of achieving the maximum interference protection from the structural metal, housings, that would usually be provided even if interference were not a consideration. The principal effort required to implement the approach is in configuration control.

35909 Radiation resistant cable and method of making same. Anderson, R.W. (to Haveg Industries, Inc.). US Patent 4,051,324. 27 Sep 1977. Filed date 12 May 1975. 4p.

A radiation resistant cable is made by wrapping a barrier film over a conductor and covering it with a silicone saturated asbestos covering. The asbestos is passed through one or more dies to compact the asbestos covering and accurately size it. One or more layers of polyimide tape is wrapped about the asbestos. The polyimide tape is covered by a heat-sealable tape over which a fiberglass cover is braided. The cable is then heated to seal the heat-sealable tape to itself as well as to the adjacent layers. The cable is then passed through a coating bath to impregnate and saturate the fiberglass braid, following which the cable is heated to extract the solvent in the coating solution.

MISCELLANEOUS INSTRUMENTS

REFER ALSO TO CITATION(S) 34333, 34334, 34336, 34337, 34338, 34340, 34341, 34342, 34343, 34348, 34351, 34362, 34385, 34399, 34404, 34506, 35223, 35730, 35927, 35931, 35935, 35987, 36016, 36017, 36175

35910 (CONF-7510172—P1, pp 85-98) **Thematic mapper performance optimization study.** Thomson, F.J. (Environmental Research Inst. of Michigan, Ann Arbor); Erickson, J.D.; Koerber, K.; Harnage, M.J. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

A six-month systems study (Contract NAS9-13386, funded by NASA/JSC) of earth resource surveys from satellites was conducted in early 1974. SKYLAB S-192 Multispectral Scanner (MSS) data were used as a baseline to aid in evaluating the characteristics of future systems using satellite MSS sensors. The study took the viewpoint that overall system (sensor and processing) characteristics and parameter values should be determined largely by user requirements for automatic information extraction performance in quasi-operational earth resources surveys, the other major factor being hardware limitations imposed by state-of-the-art technology and cost. The objective was to use actual aircraft and spacecraft MSS data to outline parametrically the trade-offs between user performance requirements and hardware performance and limitations so as to allow subsequent evaluation of compromises which must be made in deciding what system(s) to build. The analysis was conducted with the realization that these compromises might be different for different missions and systems.

35911 (CONF-7510172—P1, pp 99-111) **Practical data-processing system for digital scanner.** Takahashi, M.; Shimooka, K.; Michino, T.; Hata, J. (NAC Inc., Minatoku, Japan). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

A unique data processing/handling system co-operating with digital-type airborne multi-spectral scanner has been developed and put to practical use for remote-sensing. A series of special hardware systems reported here have been developed according to these requirements, that is, reducing cost and increasing digital scanner system advantages.

35912 (CONF-7510172—P1, pp 149-158) **SMS infrared observations: their accuracy and calibration.** Lienesch, J.H.; Bauer, B.P.; Goddard, B.B. (National Environmental Satellite Service, Washington, DC). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Observations of the earth in the atmospheric window at 10.5 to 12.5 μm are being made by the Visible and Infrared Spin Scan Radiometer on two Synchronous Meteorological Satellites. An annual variation in the instrument sensitivity and diurnal variations during the eclipse periods, at the vernal and autumnal equinoxes, have been detected. Measurements from the two spacecraft compare

well. Other satellite and ground based observations were used to estimate data accuracy of 2 K. The manner in which the in-flight calibrations are derived and applied to the observations are presented.

35913 (CONF-7510172—P2, pp 725-730) **Restoration of Landsat images by discrete two-dimensional deconvolution.** Dye, R.H. (Bendix Aerospace Systems Div., Ann Arbor, MI). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The two-dimensional point spread function of the LANDSAT multispectral line scanner is accurately approximated by the combined effects of the optical blue circle, detector size, and presampling low-pass electrical filter. The array of numerical values representing a LANDSAT image can be regarded as the result of a discrete two-dimensional convolution of the original scene with the LANDSAT point spread function. Since the point spread function is substantially wider in the along-scan direction and somewhat wider in the cross-scan directions than the corresponding sampling intervals, important improvements in both spatial resolution and radiometric accuracy for small objects can be obtained by application of a suitable deconvolution procedure prior to use of the data for thematic recognition or other processes that are sensitive to radiometric errors.

35914 (CONF-7510172—P2, pp 769-776) **Change detection in multi-sensor images.** Price, K.; Reddy, R. (Carnegie-Mellon Univ., Pittsburgh). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

We propose that change detection in images is best done at a symbolic level. A continuous multi-spectral image can be segmented into discrete regions having similiar properties and this provides the basic symbolic representation needed for change detection. In this paper we describe a picture segmentation method based on multidimensional histogram thresholding, feature extraction, and matching of the regions in two images to determine changes, if any. We illustrate its use in detection of changes in snow cover and the analysis of aircraft imagery of crop land. The results compare favorably to other known results.

35915 (CONF-7510172—P2, pp 777-782) **Color display terminal system for interactive image analysis.** Steele, R.; Senkus, W.; Flores, I.; Vasick, G.; Nichols, J. (Univ. of California, Berkeley). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

An interactive Color Display Terminal, based on semi-conductor memory for image storage, is described. The Terminal is designed to be flexible and expandable and utilizes features specifically designed for remote sensing applications. The color display can magnify and scroll an image, generate a histogram for each band displayed, delineate and define areas within the image and obtain histograms of each area, and overlay graphics on the images. A detailed explanation of its operation, including applications, will be presented.

35916 (LA—7106-MS) **Quartz crystal microbalances: a refined technique for determining changes in mass loading from frequency shifts.** Fowler, M.M.; Sedlacek, W.A. (Los Alamos Scientific Lab., N.Mex. (USA)). Mar 1978. Contract W-7405-ENG-36. 15p. Dep. NTIS, PC A02/MF A01.

Current methods of converting quartz crystal microbalance frequency shifts to mass are frequently quite inaccurate. An improved method is presented which reduces the error to a fraction of a percent. The algorithm requires a knowledge of the crystal function and the mass loading distribution.

35917 (UCRL—52401(Pt.1)) **Computer programs in BASIC language for atomic absorption flame spectroscopy. Part 1. Operating instructions.** Boyle, W.G. Jr. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Sep 1977. Contract W-7405-ENG-48. 21p. Dep. NTIS, PC A02/MF A01.

These instructions describe how to use three BASIC language programs to process data from atomic absorption spectrophotometers operated in the flame mode. These programs will also control an automatic sampler if desired. The instructions cover loading the programs, responding to computer prompts, choosing among various options for processing the data, operating the automatic sampler, and producing reports. How the programs differ is also explained. Examples of computer/operator dialogue are presented for typical cases.

35918 (UCRL—52401(Pt.2)) **Computer programs in BASIC language for atomic absorption flame spectroscopy. Part 2. Documentation.** Boyle, W.G. Jr. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Oct 1977. Contract W-7405-ENG-48. 176p. Dep. NTIS, PC A09/MF A01.

There are three computer programs, written in the BASIC language, used for taking data from an atomic absorption spectrophotometer operating in the flame mode. The programs are divided into logical sections, and these have been flow-charted. The general features, the structure, the order of subroutines and functions, and the storage of data are discussed. In addition, variables are listed and defined, and a complete listing of each program with a symbol occurrence table is provided.

35919 **Improved charcoal trap for rare gas mass spectrometry.** Reynolds, J.H.; Jeffery, P.M.; McCrory, G.A.; Varga, P.M. (Department of Physics, University of California, Berkeley, California 94720). *Rev. Sci. Instrum.;* **49**: No. 4, 547-548(Apr 1978).

A charcoal trap for progressive desorption of rare gases, including helium and neon, is described and performance data given. Cooling is by a commercial helium expansion refrigerator. Temperatures are readily controlled down to about 20 K. No cold, condensed gases are used.

WELL LOGGING INSTRUMENTATION

REFER ALSO TO CITATION(S) 34779, 35906

35920 (UCRL-Trans—11332) **Thermostable two-channel radioactivity logging apparatus.** Bakhromi, E.S.; Posikera, M.V. Translated from *Geofiz. App.;* No. 59, 94-98(1976). 7p. Dep. NTIS, PC A02/MF A01.

A thermostable two-channel radioactivity logging (RL) apparatus designed to operate at temperatures up to 220°C and a hydrostatic pressure up to 1200 kgf/cm² developed and produced for conducting operations by the gamma logging (GL) and neutron-gamma logging (NGL) methods in deep high-temperature boreholes of the Fergana Intermontane Basin is described. The outer diameter of the downhole equipment is 73 mm.

EXPLOSIONS AND EXPLOSIVES

CHEMICAL

35921 (MLM—2507) **Measurements of pressure for the TiH/sub x//$KClO_4$ system.** Chong, C.H.H.; Glaub, J.E. (Mound Facility, Miamisburg, Ohio (USA)). 10 Apr 1978. Contract EY-76-C-04-0053. 18p. Dep. NTIS, PC A02/MF A01.

An investigation was conducted to measure the pressure obtained when the pyrotechnic mixture TiH/sub x//$KClO_4$ was ignited in a confined variable-volume system. It was possible to derive an expression of the form PV/sup γ/ = k for the pressure-volume relationship obtained. This expression is a polytropic expansion of the ideal gas equation that best fits the data generated. For this particular work, values of $\gamma = 0.53$ and $k = 69.3$ were obtained where P is in megapascals and V is in cubic centimeters. In addition, estimates of the reaction rates were calculated based on the times to achieve maximum pressure for a given volume system. An explicit expression relating rate to pressure was derived by a simplified least-squares fit of the data obtained.

35922 (UCID—17652) **Characterizing high-energy-formed particulates with the scanning electron microscope/energy dispersive spectrometer system. Progress report, March—September 1977.** Casey, A.W.; Biermann, A.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 7 Dec 1977. Contract W-7405-ENG-48. 36p. Dep. NTIS, PC A03/MF A01.

A method is being sought that will allow the differentiation between particulates formed in implosions and particulates formed in explosions. The scanning electron microscope (SEM) and energy dispersive x-ray analysis (EDS) were used to measure and compare particle size, shape, surface morphology, and composition. Implosion and explosion detonations yielded spherical, smooth particles within the same size range. Although the particle size, shape, and morphology were the same for comparable samples of different detonation type, there were distinct differences in composition. It is not certain whether differences in composition reflect differences in device components or differences in the nature of the detonation (implosion or explosion).

35923 (UCRL—52353(Rev.1)) **Properties of benzotrifuroxan.** McGuire, R.R. (California Univ., Livermore (USA). Lawrence

Livermore Lab.). 14 Mar 1978. Contract W-7405-ENG-48. 28p. Dep. NTIS, PC A03/MF A01.

We have reviewed the literature and characterized benzotrifuroxan (BTF), a CO-balanced, hydrogen-free explosive that is sensitive to exploding bridgewire initiation. It has performance parameters equivalent to those of HMX-based explosives, but with a different isentrope. BTF is a chemicaly reactive material that forms compounds with electron-donating substrates. The procedures normally used to prepare BTF result in low levels of trinitrotriazidobenzene (TNTAB) that degrade its already limited thermal stability. However, BTF can be purified by recrystallization and can then be safely handled.

35924 Rapid, accurate technique for determining densities of high explosives. Lagus, P.L.; Turner, P.L.; Gaffney, E.S. (Systems, Science and Software, La Jolla, Calif. (USA)). *Propellants Explos.;* 2: No. 4, 81-84(Aug 1977).

An improved gas comparison pycnometer has been developed, based on precise differential pressure measurements coupled with a sample volume compensator. Using helium gas, volumes of solid and powdered explosives can be measured to a precision approaching one part in 10^4. Coupled with a precise mass measurement, these volumes allow densities with an uncertainty of approximately +-0.002 g/ml to be inferred. Measurements performed on various explosives have allowed assessment of the purity and homogeneity of individual samples. It is also possible to infer void percentage or porosity in pressed explosive pellets.

NUCLEAR

REFER ALSO TO CITATION(S) 35365

WEAPONRY

REFER ALSO TO CITATION(S) 36130

ENVIRONMENTAL SCIENCES, ATMOSPHERIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 35349, 35936, 35974, 36140

35925 (CONF-7510172—P1, pp 67-76) **Comprehensive description of the influence of the atmosphere on microwaves in the 0.5 to 100 GHz region by means of a computer program.** Fluess, H.J.; Eckl, W. (Messerschmitt—Boelkow—Blohm GmbH, Munich). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

For the frequency region 0.5 to 100 GHz, a computer program was written which describes the important atmospheric effects on microwave propagation. To calculate attenuation, backscattering, and refraction mathematical relations are taken from results of available investigations. Results obtained with meteorological data representative for Germany are shown. Examples for the application are shown for the reduction of the detection range of a radar and the contrast reduction of a radiometer.

35926 (CONF-7510172—P1, pp 113-122) **Remote measurement of the atmospheric temperature by Raman lidar.** Coney, T.A.; Salzman, J.A. (Lewis Research Center, Cleveland). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The Raman shifted return of a lidar system has been used to measure vertical temperature profiles in the atmosphere. Temperature profiles were obtained for surface temperatures ranging from -2°C to 24°C and for altitudes between 94 and 410 meters. The accuracy of the technique in measuring the absolute temperature was about +-4°C at a 100 meter altitude. The precision in measuring the relative temperature was +-2°C at 100 meter and +-8°C at 400 meter. Appropriate normalization of the data and off-the-shelf system improvements will significantly increase both the absolute accuracy and the maximum altitude.

35927 (CONF-7510172—P1, pp 123-130) **Micro and mesometeorological information by means of remote sensing techniques.** Lindqvist, S. (Univ. of Gothenburg, Sweden); Mattsson, J.O. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

This paper concentrates on the surveying of micro and mesometeorological information by means of remote sensing techniques, such as airborne and groundbased equipment for infrared thermography, airborne laser scanners, airborne cameras in combination with flashlight aggregates and ERTS-1 images.

35928 (CONF-7510172—P1, pp 163-172) **Multiple Doppler radar observations of tornadic storms.** Ray, P.S.; Wagner, K.K. (National Severe Storms Lab., Norman, OK). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The use of radar to infer dynamical structure from storms is extended by employing two or more coherent radars, positioned to allow construction of the three dimensional wind field. On June 8, 1974 tornadic storms passed between the two NSSL Doppler radars. Both radars simultaneously collected Doppler data throughout these storms. Objectively analyzed wind and reflectivity fields reveal the spatial distribution of vorticity, divergence and rainfall rates. There exists a strong updraft NE and a downdraft SW of the vorticity center associated with the weak echo intrusion. Updrafts are correlated with regions of high reflectivity, suggesting importance in growth and concentration of hail. Strongest convergence is noted in the weak echo region and between opposing vorticity centers. The analysis implications of using more than two Doppler radars is discussed.

35929 (CONF-7510172—P1, pp 183-186) **Remote sensing for global atmospheric research program.** Epstein, E.S. (National Oceanic and Atmospheric Administration, Rockville, MD). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The Global Atmospheric Research Program (GARP), a concerted international program, including both government and private institutions, is a program for studying those physical processes in the troposphere and stratosphere that are essential for understanding the behavior of the atmosphere and its general circulations. Specifically, the transient behavior of the atmosphere is manifested in the large-scale fluctuations which control changes of weather, an understanding of which would lead to increasing the accuracy of forecasting over periods from one day to several weeks. The factors that determine the statistical properties of the general circulation of the atmosphere would lead to better understanding of the physical basis of climate. GARP is an integrated program of computational, theoretical models, as well as observational and experimental studies of the atmosphere. This paper addresses the observational techniques, especially remote sensing concepts and methods. It is clear that no single observing technique will be capable of meeting the observational requirements, and that a composite global observing system is necessary. Thus, both in situ and remote sensing techniques will be utilized in concert. However, because of the needs and platforms of global detailed information for this program, the remote sensing techniques will play a key role in the observational program.

35930 (CONF-7510172—P2, pp 671-682) **Signature variations due to atmospheric effects.** Turner, R.E. (Environmental Research Inst. of Michigan, Ann Arbor). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

In the analysis of multispectral remote sensing data it has been noticed that there is an influence of background on target as a result of scattering by the atmosphere. If this effect is strong, then the spectral signature of a class of materials will depend upon the surface spatial pattern, the reflectances of the materials composing the background, the atmospheric state, and the geometric conditions such as sun angle and view angle. The effect of neglecting the background interference is similar to the effect of including a high degree of atmospheric spatial inhomogeneity throughout the scene. To solve the problem we found a single-scattering solution of the radiative-transfer equation for a point source and then integrated that solution over a surface spatial pattern characteristic of natural agricultural materials. The results of the calculations show the change in signal level for specific targets using LANDSAT channels with a variety of background materials. The change depends upon visibility conditions, solar zenith angles, and the type and spatial distribution of background materials. Although only perfectly diffuse (Lambertian) surfaces have been considered, the mathematical formulas are general enough so that a surface with any goniometric properties can be considered.

35931 (CONF-7510172—P2, pp 783-792) **Optical atmospheric scattering and absorption limitations on offset pointing.** Egan, W.G.; Fischbein, W.L. (Grumman Aerospace Corp., Bethpage, NY). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

An analysis has been conducted on the effect of atmospheric attenuation on universal apparent contrast for a new set of satellite sensors operated at very large offset or pointing angles. An AFCRL standard atmosphere was used in a Braslau-Dave 41 layer model to determine these effects, and a comparison was made with contrast degradation at a remote sensing aircraft altitude (11 kg). These new sensors are propsed for the next generation of Earth Observatory Satellites (EOS) and include the Thematic Mapper (TM) and High Resolution Pointable Imager (HRPI). The TM offset off nadir could be +-20° with an 11° scan angle, and the HRPI pointing angle off nadir could be as great as +-45° with a 3° scan angle. Crucial to the program is the reduction of universal apparent contrast in the satellite imagery caused by atmospheric absorption and scattering; the path length for the HRPI at a 45° pointing angle would be 70% greater than that from the 11° scan angle of the ERTS-1 multispectral scanner. The contrast reduction is a function of sun elevation angle, atmospheric aerosol loading, radiation wavelength, and sensor look angles, all of which are included in the analysis.

35932 (EPR—76-6) **Five-year averages of diurnal and seasonal climate in the first 150 meters of the atmosphere at selected sites in the United States.** Torrance, K.E.; Black, S.H.; Lykins, L.G. (Cornell Univ., Ithaca, N.Y. (USA). Sibley School of Mechanical and Aerospace Engineering). 15 Nov 1976. Contract EY-76-S-02-2924. 35p. Dep. NTIS, PC A03/MF A01.

Diurnal profiles of windspeed and air temperature near ground level are presented for selected sites. The sites are LaGuardia and Binghamton, New York, Kansas City, Missouri, and Las Vegas, Nevada. Meteorological data was averaged over a five-year period to obtain climatic averages for representative months. Vertical profiles of windspeed and air temperature for the sites were constructed over height ranges characteristic of natural draft cooling towers. Frequency distributions of windspeeds and inversions are also presented.

35933 (ORNL/CSD/TM—40) **WNDROS: a program for displaying wind rose data.** Schlatter, E.C. (Oak Ridge National Lab., Tenn. (USA)). Mar 1978. Contract W-7405-ENG-26. 22p. Dep. NTIS, PC A02/MF A01.

The FORTRAN IV program WNDROS uses the computer graphics system DISSPLA to produce a wind rose plot. The plot indicates wind frequency at a site as a function of wind speed and direction as read from Star data listings of the Environmental Data Service, National Climatic Center, NOAA. Options are available which allow the user to control the final appearance of the plot. A program description, user's guide, a data sample, a finished plot, and FORTRAN and JCL listings are included.

35934 (RHO-SA—33) **Risk analysis in environmental studies. I. Risk analysis methodology: a statistical approach; II. Data management for environmental studies.** Rubinstein, S.; Horn, R.L. (Atomics International Div., Richland, Wash. (USA). Rockwell Hanford Operations). Mar 1978. Contract EY-77-C-06-1030. 26p. (CONF-780316—8). Dep. NTIS, PC A03/MF A01.

From Waste management fuel cycles; Tucson, AZ, USA (5 Mar 1978).

A new approach to Risk Analysis as applied to Environmental Studies is proposed in this paper. Advantages of this methodology are pointed out. It utilizes modern statistical methods in order to treat risk analysis as an integral part of the study design.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 34936, 34937, 36086, 36099

35935 (ANL—78-7, pp 228-254) **On-line monitoring of particulates.** Trolinger, J.D.; Busch, C.W. (Spectron Development Labs., Inc., Costa Mesa, CA). 1977.

From Symposium on instrumentation and control for fossil demonstration plants; Chicago, IL, USA (13 Jul 1977).

In Proceedings of the 1977 symposium on instrumentation and process control for fossil demonstration plants.

Recent applications of optical instrumentation systems demonstrate their utility for critical measurements in coal processing systems. They have been successfully employed in a wide range of harsh conditions, including high temperature and pressure flows and severe mechanical environments. Both particle field and gas flow properties have been measured. Optical instruments offer a unique combination of advantages including high accuracy and in-situ, real time data acquisition with instrument hardware remote from the flow being monitored. Consequently, they are ideal candidates for use in executing critical control functions. Carefully selected optical techniques and optimally designed configurations can be employed for coal processing measurements. Candidate systems vary in level of complexity and data detail provided and can be matched up with specific measurement requirements in demonstration plant operation.

35936 (CONF-7510172—P2, pp 695-703) **Determination of haze levels from Landsat data.** Potter, J.F.; Mendlowitz, M.A. (Lockheed Electronics Co., Inc., Houston, TX). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Two methods are described for determining haze levels from Landsat data. In one, the haze level is related to the y-intercept of a regression line through a plot of the data in the plane of multispectral scanner bands MSS 4 and MSS 5. In the other, the haze level is related to the minimum values observed in MSS 4. In both cases, a significant correlation is obtained with measured haze levels.

35937 (MLM—2487) **Isotope applications in the environmental field.** DeWitt, R. (Mound Facility, Miamisburg, Ohio (USA)). 17 Feb 1978. Contract EY-76-C-04-0053. 34p. Dep. NTIS, PC A03/MF A01.

Established uses of enriched isotopes in the environmental field were surveyed to determine future trends in isotope needs. Based on established isotope uses, on the projected increase in the pollution problem, and on the apparent social and economic pressure for pollution abatement, a significant demand for enriched isotopes appears to be developing for the assessment and control of air, water, and soil pollutants. Isotopic techniques will be used in combination with conventional methods of detection and measurement, such as gas chromatography, x-ray fluorescence, and atomic absorption. Recent advances in economical isotope separation methods, instrumentation, and methodology promise to place isotopic technology within the reach of most research and industrial institutions. Increased application of isotope techniques appears most likely to occur in areas where data are needed to characterize the movement, behavior, and fate of pollutants in the environment.

35938 (TID—28403) **Trace element analysis of fuel cycle effluents. Quarterly progress report No. 1, for period ending November 30, 1977. RPI Research Project No. JBE53.** Malaviya, B.K.; White, F.A. (Rensselaer Polytechnic Inst., Troy, N.Y. (USA). Dept. of Nuclear Engineering). Dec 1977. Contract EX-77-S-02-4439. 19p. Dep. NTIS, PC A02/MF A01.

The objective of this research project is to analyze the trace elements in gaseous and liquid effluents and wastes from fossil fueled power plants in order to assess the emissions at different stages of the fossil (especially coal) fuel cycle and to compare these with nuclear fuel cycle effluents and wastes. The emphasis is on effluents of radiological significance (primarily uranium and thorium) so as to obtain a basis for the comprehensive evaluation of the health effects and total engineering and social costs associated with these fuel cycles. During the first quarter, effort has been primarily directed toward project organization, literature searches, sample preparation and treatment techniques, identification of sample sites, planning for the acquisition of several types of environmental samples, instrumentation development, and evaluation of trace element assay techniques. Preliminary analysis has been performed using some initial test samples.

35939 **Comparability of CO_2 measurements.** Bischof, W. (Univ. of Stockholm). *Tellus;* **29**: 435-444(1977).

In measuring the atmospheric CO_2 concentration, corrections for the carrier gas effect are required at present for each individual gas analyzer. It is shown that standard gases of CO_2/air composition offer less complication in the data comparison than CO_2/N_2 standards which are most commonly being used for calibration. CO_2/air standards which are used in Stockholm and related to the Scripps manometric calibration scale have remained stable over more than 10 years. Aircraft data from the upper troposphere and the lower stratosphere obtained in the Stockholm project are in fair agreement with data from the Mauna Loa and the South Pole stations. An accelerating increase over the period 1963 to 1975, i.e. about 0.5 ppM/yr at the beginning and about 1.3 ppM/yr at the end of the period, has been observed.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 35938, 35986, 36086

35940 (EML—339) **Environmental Measurements Laboratory environmental quarterly, December 1, 1977—March 1, 1978.** Hardy, E.P. Jr. (Department of Energy, New York (USA). Environmental

Measurements Lab.). 1 Apr 1978. 68p. Dep. NTIS, PC A04/MF A01.

This report presents current information from the EML environmental programs. The initial section consists of a report on chemical analyses of deposition samples by nineteen laboratories. Subsequent sections include tabulations of radionuclide and stable lead concentrations in surface air and strontium-90 in deposition, milk, diet and tap water. A bibliography of recent publications related to environmental studies is also presented.

35941 (EML—339(App.)) **Appendix to Environmental Measurements Laboratory environmental quarterly.** (Department of Energy, New York (USA). Environmental Measurements Lab.). 1 Apr 1978. 207p. Dep. NTIS, PC A10/MF A01.

The following appendices are presented: quarterly ^{90}Sr deposition at world land sites; radionuclides and lead in surface air; radiostrontium in milk and tap water; table of conversion factors; and table of radionuclides. (HLW)

35942 (PNL—2280) **Comparative biogeochemical behaviors of iron-55 and stable iron in the marine environment.** Weimer, W.C.; Langford, J.C.; Jenkins, C.E. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 6 Feb 1978. Contract EY-76-C-06-1830. 32p. Dep. NTIS, PC A03/MF A01.

Studies of atmospheric aerosols have demonstrated that much of the ^{55}Fe associated with the aerosol input to the oceans is present as either an amorphous or hydrous iron oxide or as very small particulate species attached to the surfaces of the large aerosol particles. By comparison, nearly all of the stable iron is bound in the mineral phase of aerosol particles. This difference in the chemical and physical forms of the radioactive and stable iron isotopes results in the ^{55}Fe being more biologically available than is the stable iron. This difference in availability is responsible for the transfer of a much higher specific activity ^{55}Fe to certain ocean organisms and man relative to the specific activity of the total aerosol or of sea water. This differential biological uptake of the radioactive element and its stable element counterpart points out that natural levels of stable elements in the marine environment may not effectively dilute radioelements or other stable elements of anthropogenic sources. The effectiveness of dilution by natural sources depends on the chemical and physical forms of the materials in both the source terms and the receiving environments. The large difference in specific activities of ^{55}Fe in aerosols and sea water relative to ocean organisms reflects the independent behaviors of ^{55}Fe and stable iron.

35943 (ORNL-tr—4289) **Calculation of the gamma dose rate from a continuously emitted radioactive plume.** Huebschmann, W.; Papadopoulos, D. (Kernforschungszentrum Karlsruhe (Germany, F.R.)). [nd]. Translation by S.D. Blalock Jr. of KFK—2172. 33p. Dep. NTIS, PC A03/MF A01.

A computer model is presented which calculates the long-term gamma dose rate caused by the radioactive off-gas continuously emitted from a stack. The frequency distribution of the wind direction and velocity and of the stability categories is taken into account. The emitted activity, distributed in the atmosphere according to these statistics, is assumed to be concentrated at the mesh points of a three-dimensional grid. The grid spacing and the integration limits of the individual dose amounts determine the accuracy as well as the computer time needed. When calculating the dose rate in a given wind direction, the contribution of the activity emitted into the neighboring sectors is evaluated.

ENVIRONMENTAL SCIENCES, TERRESTRIAL

BASIC STUDIES

REFER ALSO TO CITATION(S) 35369, 35497, 35912, 35914, 35927, 35934, 35995, 35998, 36136, 36146, 36147

35944 (CONF-7510172—P1) **Proceedings of the tenth international symposium on remote sensing of environment.** (Environmental Research Inst. of Michigan, Ann Arbor (USA)). 1975. 728p. Dep. NTIS, PC A99/MF A01.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

Separate abstracts were prepared for the 72 papers included in the first volume of papers presented at the conference. (HLW)

35945 (CONF-7510172—P2) **Proceedings of the tenth international symposium on remote sensing of environment.** (Environmental Research Inst. of Michigan, Ann Arbor (USA). Center for Remote Sensing Information and Analysis). 1975. 838p. Dep. NTIS, PC A99/MF A01.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

Separate abstracts were prepared for the 81 papers included in the second volume of papers presented at the conference. (HLW)

35946 (CONF-7510172—P2, pp 745-755) **New image enhancement algorithm with applications to forestry stand mapping.** Kan, E.P. (Lockheed Electronics Co., Inc., Houston, TX); Lo, J.K.; Smelser, R.L. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The theory and applications are presented of a new image enhancement algorithm which refines computer classification maps of multispectral data. The refinement eliminates connected sets smaller than a prespecified size and merges them to the surrounding area. Conventional practices in forestry timber stand mapping requires small geographic areas to be absorbed by surrounding large areas to form homogeneous stands. This homogeneity is often incompatible with the statistical formulation of homogeneity. Elements within a timer stand which should be labeled as one feature often correspond to more than one class mapped by existing computer classification techniques. The new algorithm is designed to postprocess classification maps to result in more usable timber stand maps. The new image enhancement technique is compared with an accepted neighbor-checking post-processing technique, demonstrating the superiority of the new technique for forestry stand mapping.

35947 (CONF-7510172—P2, pp 803-810) **Remote sensing of landslide hazards of quick clays of Eastern Canada.** Gagnon, H. (Univ. of Ottawa). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

A system for landslide detection is deveoped through twenty factors established from aerial imagery analysis of many landslides that occurred on post-glacial marine silts and clays of Eastern Canada. A landslide risk score is given for every piece of land. The system distinguishes slope factors from upper surface factors (terrace) and allows the separation of slump risks from clayey outflow risks. Some examples are mentioned.

35948 (CONF-7510172—P2, pp 811-820) **Worldwide disaster warning and assessment with Earth Resources Technology Satellites.** Robinove, C.J. (Geological Survey, Reston, VA). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Images of the Earth collected by ERTS-1 and later experimental and operational satellites can be used for the warning and assessment of disasters throughout the world. Floods, fire, glacier movement, and drought are the disasters most amenable to satellite sensing and analysis. Other disasters to which applications are promising but not yet completely feasible are earthquakes, volcanic eruptions, crop failures, and water pollution. Practical application of satellite images to disaster assessment requires the continued and reliable operation of satellites and data reception stations, rapid distribution of data to interpretive teams and to affected countries, and the rapid analysis and dissemination of maps and other results.

35949 (CONF-7510172—P2, pp 821-823) **Truth about ground-truth maps.** Smedes, H.W. (Geological Survey, Denver). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The purpose of this paper is to explain how maps of the terrain surface prepared from remote-sensing data by the computer can be more accurate than so-called "ground-truth" maps. The paper addresses the concept of ground truth, which means a map or maps that accurately show the distribution and types of classes of the terrain surface materials. Terrain-surface classes comprise only the surface features of the land, such as exposed bedrock and soil, vegetation, water, snow, and man-made features. The terrain surface is also that which can be detected by remote sensing. The purpose of ground-truth maps is to serve as control data from which the accuracy of remote-sensing maps can be calculated. Remote-sensing maps include those made by optical and/or electronic density-level slicing of images, by electronic display of ratios of different spectral bands, by color additive enhancement, and by computer from multispectral scanner data. Because the accuracy of remote-sensing maps is determined by comparison with the ground-truth map, there is an implied assumption that the latter more-closely approaches the "truth." This may be valid for maps of the distribution of types of bedrock, much of which is not exposed. However, for maps of the terrain surface it is not valid. A premise of this paper is that it is not

only infeasible but virtually impossible to prepare a truly accurate ground-truth map. Generally, for those classes that can be distinguished from one another by spectral signature or other remote-sensing attributes, the remote-sensing map is more accurate than the ground-truth map. It is a matter of practice that the ground-truth map is upgraded by the remote-sensing map data.

35950 (CONF-7510172—P2, pp 825-834) **Place and significance of radar survey in the complex of remote sensing methods used in the USSR for study of environment.** Komarov, V.B.; Starostin, V.A. (Lab. of Aeromethods, Leningrad). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

In recent years SLAR system "Toros" has been greatly interested by different specialists for the study of environment. This system is irreplaceable mean for obtaining the images of the regions covered by heavy clouds and which should be studied at the shortest time. Besides geological investigations and study of ice conditions the radar images have been started to use for study of water pollution, soil and crop investigations, hydrological explorations etc. It has been established on the base of methodological investigations carried out by different specialists that the radar images served as a kind of bridge in passing from the materials of traditional aerial photography to extra small scale images obtained from space altitudes. These steps are clearly visible while geological investigations.

35951 (CONF-7510172—P2, pp 879-892) **Look at Alaskan resources with Landsat data.** Miller, J.M.; Belon, A.E.; Gedney, L.D.; Shapiro, L.H. (Univ. of Alaska, Fairbanks). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

LANDSAT data remains a vital tool for the management of resources in Alaska. Utilization of these data by many agencies in Alaska trends toward the solution to operational problems in a wide spectrum of disciplinary applications. Four examples of current applications are reviewed briefly: mapping of coastal sediment plumes, mapping of coastal zone ecosystems, mapping of landform and ground cover for proposed national parks and forests, and evaluation of seismic risks for a proposed hydroelectric project.

35952 (CONF-7510172—P2, pp 911-914) **Some results obtained by applying remote sensing in exploration of mineralized zones in Yugoslavia.** Koscec, J.; Koscec, B.; Denih, M.; Knapp, M. (Industroprojekt, Zagreb). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

By analyses of the images shown here and of many others, it is proved that the highest thermal effects are yielded by altered volcanic rocks, carbonate clastics of Upper Cretaceous and andesites. Higher thermal effects are due to the same areas and rocks as it is the case with the daylight image, but the effect is restricted in extent. On the "8 level" night image are pinpointed the spots with highest thermal effects clearly evident. Altered rocks in the study area are the bearers of copper mineralization. On the thermal maps shown those rocks yielded, higher and highest thermal effects some of which point to the ore-bearing zones located during the previous geological, geophysical and geochemical exploration.

35953 (CONF-7510172—P2, pp 933-948) **Geologic interpretation of Landsat-1 imagery of the greater part of the Michigan basin.** Drake, B. (Environmental Research Inst. of Michigan, Ann Arbor); Vincent, R.K. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

A LANDSAT-1 mosaic of the Southern Peninsula of Michigan consisting of spring, 1973 color composites was studied with the unaided eye using photogeologic interpretation techniques. Mainly Wisconsin glacial deposits can be discriminated on the mosaic, and there is a strong correlation between the land use, or at least the land cover, in the Southern Peninsula and the types of geologic features discriminated on the mosaic. The glacial deposits and features that can be locally discriminated on the mosaic are end and lateral moraines, ground moraines and outwash plains, ice-contact stratified drift, a delta, lake beds, glacial lake shorelines and beaches, and glacial drainage channels. The use of the LANDSAT-1 mosaic along with glacial and topographic maps will allow many of the glacial deposits and features and the extent and boundaries of them to be revised and mapped better. Several Recent geologic features also can be seen on th mosaic. These include quarries, the St. Clair River delta, sinkhole lakes, and shoreline features along the shores of the peninsula. LANDSAT imagery of the Southern Peninsula taken over a period of years will allow the monitoring of many features and processes, including quarrying activities; temporal and spatial changes in rivers and lakes, including sinkhole lakes; and temporal and spatial changes in shoreline features, including the gross erosion and deposition along the shores of the Great Lakes and Lake St. Clair.

35954 (CONF-7510172—P2, pp 949) **Computer-assisted analysis of ERTS-1 data for mapping of superficial deposits in the Alta test area, Finnmark County, Norway.** Follestad, B.A. (Norwegian Geological Survey, Trondheim). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

A data processing system developed in the Laboratory for Applications of Remote Sensing was applied to a study of marginal stratified deposits and proglacial deposits. The marginal deposits consist mostly of a material characterized by large variation in grain size. This is as expected for deposits in immediate contact with a (wasting) glacier. The proglacial deposits (also including glaciomarine sediments) are accumulations deposits beyond the limits of the glacier. They have, in most cases, lesser variation in grain size than the marginal deposits. The properties of the different grain sizes, etc., have favored different kinds of vegetative canopies, which to a certain degree can be separated on the basis of the differences in spectral reflectance. It was found that the reflectivity of pine wood (Norwegian pine) with a certain density, in most cases, dominated by the proglacial deposits, the number of birch trees increases in the pine wood. This affects the spectral reflectivity markedly and can be detected rather easily by the analysis. Most of the areas having the spectral reflectiveness characteristic of bog below marine limit would in most of the cases indicate an underlying, rather impermeable, proglacial accumulation. In areas heavily affected by shadow, the classification was meaningless. These areas could easily be located on both printouts and the topographic maps of the area.

35955 (CONF-7510172—P2, pp 951-963) **Mapping in the Craters of the Moon volcanic field, Idaho with Landsat (ERTS) imagery.** Lefebvre, R.H. (Geological Survey, Reston, VA). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Lava flows in the Craters of the Moon (COM) National Monument, Idaho, and its surrounding recent volcanic field, show significant radiance variations on LANDSAT (ERTS) images. Preliminary mapping has been conducted using digital LANDSAT imagery in conjunction with analysis of aerial photographs and field observations. The radiance variations are mainly due to three surficial properties of the flows: surface roughness, a result of the type of flow (aa, rough-surfaced or pahoehoe, relatively smooth); surface chemistry and mineralogy and its effect on the blue glassy coating of the exterior of the pahoehoe flows; and surface cover on the pahoehoe flows by weathering, vegetation, and sediment. Surface roughness allows discrimination between aa and pahoehoe flows. Surface chemistry and mineralogy and surface cover make it possible to delineate between pahoehoe flows of different ages. Digital processing of these radiance variations provides investigators with a broad regional and multispectral perspective for geologic mapping of Holocene flows. The lack of accessibility and the predominance of minor features, such as flow units, make the Craters of the Moon (COM) area and others like it difficult areas to study. Using LANDSAT in conjunction with aerial photographs and field investigations has resulted in the following: The border of the COM volcanic field has been defined by contrast stretching of the light areas on the LANDSAT image. The individual lava flows within the volcanic field have been delineated by contrast stretching of the dark areas. Classification of the LANDSAT digital data supervised by the investigator on interactive computers such as the General Electric Image-100 make it possible to map individual flows in detail.

35956 (CONF-7510172—P2, pp 975-984) **Correlation of ERTS spectra with rock/soil types in Californian grassland areas.** Levine, S. (Stanford Univ., CA). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

A seasonal study of ERTS-CCT data, accomplished by means of four band spectra plots of normalized reflectance, indicates that in the San Francisco Bay and adjacent Coast Range grassland areas, soils mapping or classification by computer techniques is possible at the end of the dry or grass dieback season. Excellent correlation is shown between ground reflectance measurements and CCT data at three test sites and two different soil types: serpentine and sedimentary. The uniqueness of their spectra is then demonstrated by the successful application of STANSORT, a computerized classification technique developed by the Stanford Remote Sensing Laboratory.

35957 (CONF-7510172—P2, pp 985-994) **Thermal inertia mapping.** Kahle, A.B.; Gillespie, A.R.; Goetz, A.F.H.; Addington, J.D. (Jet Propulsion Lab., Pasadena, CA). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

A thermal model of the Earth's surface has been developed and used to determine the thermal inertia of a test site in the Mojave Desert, California. The model, which includes meteorological heating terms as well as radiation and conduction heating terms, is used with remotely sensed surface temperature data to determine thermal inertia of materials. The thermal inertia is displayed in image form, and can aid in the differentiation of the various lithologic materials in the test site.

35958 (CONF-7510172—P2, pp 1023-1027) **Study of land formation in Bangladesh with Landsat-I imageries.** Hossain, A.; Chaudhury, M.U. (Bangladesh National Landsat Programme, Dacca). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

A Landsat-I image format of Bangladesh taken on 20th February, 1973 during its 1212th orbit was studied. The study was concentrated in one of the test site areas of Bangladesh National Landsat Programme in the Patherghata Police Station of the Patuakhali district encased between 21°30′ N and 21°45′ N latitude and 89°53′ E and 90°03′ E longitude. A black and white print of the area in band-6 blown to a scale of 1 : 250,000 was used for detailed study. Aerial photographic mosaics of the area taken at different scales and at different times and coloured diazoprint of bands 4, 5 and 7 of the same area at a scale of 1 : 1,000,000 were also studied. The ground truth data was collected during visits to the area in water crafts and also through visual observations and from the oblique photographs taken during low-altitude helicopter reconnaissance flights over the area. Land formations as indicated in the Landsat imageries and further future accretion was confirmed. The findings revealed information on huge land formation in the Bay of Bengal which is increasing the land area of Bangladesh.

35959 (CONF-7510172—P2, pp 1031-1044) **Correlation between ground metal analysis, vegetation reflectance, and ERTS brightness over a molybdenum skarn deposit, Pine Nut Mountains, western Nevada.** Lyon, R.J.P. (Stanford Remote Sensing Lab., CA). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

In a cooperative study with U.S.G.S. and American Metals Climax (AMAX) personnel, it has been possible to detect a 2.0 by 1 mile anomaly on ERTS CCT data directly, in the pine- and juniper-covered mountains of western Nevada. This anomalous area is about 3—5 times larger than that of the known geobotanical anomaly which lies centrally within the area. The site has been studied on the ground and bi-directional reflectances (relative to $BaSO_4$) obtained for 40 trees, using both in-vivo techniques (similar to cherry picker operations) and field determinations of cut branches. The anomaly can be seen best by color transparencies made from 5/4, 6/4, 7/4 ratioed ERTS data, the 3 ratios each being coded by one of 3 colors (blue, green, and red). Ratio-image 7/4 is the best single view of these three ratios.

35960 (CONF-7510172—P2, pp 1045-1055) **Correlation of Landsat-1 multispectral data with surface geochemistry.** Ballew, G.I. (Stanford Univ., CA). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

LANDSAT-1 (ERTS-1) multispectral scanner digital data were compared to surface geochemical data consisting of 126 samples from Washington Hill mercury mining district in the north central portion of Virginia City 15-minute quadrangle, Nevada. The digital data were not corrected in any way, although a scene with a sun elevation of 59° (July 25, 1972) was chosen to minimize effects of topography on illumination. All of the samples were analyzed for Hg, Au, Ag, Pb, Cu and Bi and were from the Kate Peak formation, with all but three samples being from bleached andesite areas. The four MSS channel values and their six ratios, four logs and six logs of ratios were correlated with metal concentration and log of metal concentration for each of the six metals. Assuming that the data are normally distributed, linear relationships with a probability greater than 0.90 exist for channels or functions of channels and Hg, Pb, Cu, Bi, log Hg, log Ag, log Pb, log Cu and log Bi concentrations. Multiple regression analysis was used to determine the best channels or channel functions for predicting metal content. Multiple correlation of regression equations with metal content indicates that linear relationships with a probability greater than 0.90 exist for Hg, Pb, log Hg, log Ag, log Pb and log Bi content METMAP, a computer program for predicting metal content by use of regression equations, was used to analyze a 15-square-km area of bleached Kate Peak formation. Metal anomalies corresponding to alteration patterns which surround highly bleached areas and the location of known mines and prospects were predicted. Major northeast-trending anomalies which indicated alternating zones of Hg-Cu-Ag and Pb-Bi-Au mineralization were indicated by the METMAP program. The close association of conifers with many of the anomalies agrees well with western Great Basin studies made by Billings, which show a close relationship between ponderosa pines and soils low in phosphorus and high in acidity.

35961 (CONF-7510172—P2, pp 1057-1065) **Regional mapping program and mineral resources survey based on remote sensing data.** Correa, A.C. (Instituto de Pesquisas Espaciais Sao Jose dos Campos, Sao Paulo, Brazil). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The Earth Resources Technology Satellite-1 (ERTS-1, now called LANDSAT-1) has obtained multiband imagery that has been used as the basis for the structural mapping of the middle Sao Francisco River area, eastern Brazil. The synoptic view available from orbital imagery provided the means to detect geological structures already mapped in some areas and to revise small scale geological maps. The capability of LANDSAT-1 imagery to provide structural data for geological studies was utilized to its full extent. Data from other remote sensors, mainly side looking airborne radar (SLAR) imagery and aerial photography were analyzed when available. The reliability of the interpretation of structural features for the Rio Sao Francisco quadrangle was further increased by using all the information available from the literature and by field work in selected areas. Relatively small occurrences, mainly of gold, diamonds, rutile, and lead and zinc ore, found in the study area are restricted to Precambrian units. The identification of new crustal fractures, and particularly the intersection of sets of linear features, which control to a great extent the formation of some types of ore deposits, are some of the data which were considered when defining areas with potential mineralization. These areas are recommended for further detailed study, both in the field or with airborne geophysical techniques.

35962 (CONF-7510172—P2, pp 1067-1075) **Enhancement of geologic features near Mojave, California by spectral band ratioing of Landsat MSS data.** Merifield, P.M. (California Earth Science Corp., Santa Monica); Lamar, D.L.; Lamar, J.V. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

A number of geologic features in the western Mojave Desert are enhanced in spectral ratio images which include Band 4 of Landsat MSS data. Alluvial fans of different ages, which are indistinguishable in single spectral band images, are readily differentiated. Subtle differences in soil color, apparently due to variations in hydrous iron oxide content, are enhanced on the ratio images. Differences in the density and type of vegetation may also be reflected on the images. Other geologic features enhanced relative to their surroundings include an iron oxide gossan around the once productive Middle Butte mining area and a marble unit presently being quarried for the manufacture of cement. Calcareous and alkaline soils of low fertility are easily distinguished because of their relative dark appearance on the ratio images.

35963 (CONF-7510172—P2, pp 1079-1092) **Airphoto analysis in the tropics: crop identification.** Philipson, W.R.; Liang, T. (Cornell Univ., Ithaca, NY). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Keys for identifying major crops of the tropics on medium scale, panchromatic aerial photographs are developed, based on directly and indirectly observable field, management and crop features. Crops considered include sugar cane, lowland rice, maize, tobacco, pineapple, banana, rubber, coconut, coffee and cacao.

35964 (CONF-7510172—P2, pp 1093-1099) **Total timber resource inventory based upon manual and automated analysis of Landsat-I and supporting aircraft data using stratified multistage sampling techniques.** Titus, S.; Gialdini, M.; Nichols, J. (Univ. of California, Berkeley). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Results of a timber resource inventory for the Plumas National Forest (465,000 HA) in California are reported. The survey was based upon manual and automated analysis of LANDSAT-I and supporting aircraft and ground data using stratified multistage sampling techniques. The survey was completed in six months time and estimated a number of parameters. Cubic meter volume was estimated to be 167 m^3/HA with a sampling error of 7.8 percent.

35965 (CONF-7510172—P2, pp 1101-1109) **Reflectance properties of grazing pastures as determined in the Landsat satellite bandpasses and from oblique colour-infrared aerial photography.** Duggin, M.J. (CSIRO Div. of Mineral Physics, Sydney); Roberts, R.J.; George, J.M. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

An experiment is reported in which ground-based vertical radiometric measurements of the canopy reflectance properties of a grazing treatment, in the bandpasses which are used by LANDSAT, were used to evaluate the potential of vertical aerial or satellite imagery to distinguish differences between pastures. Analyses of variance showed that, for each bandpass, there were significant differences (to $P < 0.001$) between the reflectance factors viewed from the vertical for pastures grazed by different sheep breeds, which lambed at different times and were stocked at different rates. This paper is also concerned with the assessment of oblique imagery techniques for studies of grasslands. Oblique aerial photography using colour-infrared film is an inexpensive technque which has been used qualitatively to study seasonal changes in pasture condition during a sheep grazing experiment at Armidale, NSW, Australia. In order to find whether oblique imagery could yield quantitative information which could be related to imagery obtained from the vertical, we determined the significance of the relationships between radiance detected by the oblique imagery and vertical measurements of the reflectance factors at ground level. The radiance detected obliquely was significantly related to that which would have been detected from the vertical only in the visible part of the spectrum, for solar zenith angles less than 60°.

35966 (CONF-7510172—P2, pp 1111-1121) **Feasibility of monitoring croplands with radar.** Bush, T.F.; Ulaby, F.T. (Univ. of Kansas Center for Research, Inc., Lawrence). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

An experiment was performed to determine the dependence of the scattering coefficients of wheat, corn and alfalfa on the measurable properties of these crops. It was determined that for wheat and alfalfa the greatest sensitivity of $sigma^0$ to plant development occurred at nadir while for corn, angles of incidence in the 50° through 70° region were optimum. Furthermore, for all three crops it was possible to functionally relate $sigma^0$ to the measurable crop properties at selected angular ranges.

35967 (CONF-7510172—P2, pp 1123-1131) **Use of a remote reflectometer and digital data analysis to study phosphate deficiency in spruce trees.** Drewett, R.J. (Plessey Radar Research Center, Havant, Eng.). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The paper describes a series of measurements carried out in 1974 to determine the spectral characteristics of Sitka spruce trees subjected to phosphate deficiency, in order to determine the feasibility of detecting this form of stress by multiband photographic methods.

35968 (CONF-7510172—P2, pp 1133-1140) **Remote sensing applications for agricultural fields in Japan.** Shimoda, H.; Sakata, T.; Nakamura, K. (Tokai Univ., Hiratsuka City, Japan). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The operationality evaluation of crop identification by remote sensing technique in Japan was studied from view points of classification accuracy and cost effectiveness. From experiments, results on necessary ground classification accuracies and cost evaluation were obtained.

35969 (CONF-7510172—P2, pp 1141-1147) **Influence of soil moisture on the microwave response from terrain as seen from orbit.** Moore, R.K.; Ulaby, F.T.; Sobti, A. (Univ. of Kansas Center for Research, Inc., Lawrence). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The space operation of the S-193 Radiometer/Scatterometer on board Skylab provided data that was used to determine the influence of soil moisture on microwave response from terrain. A description of the sensors can be found in Moore et al [1974]. The resolution cell size for the scatterometer ranged from approximately 100 sq. kms for nadir incidence to approximately 380 sq. kms for 52° incidence. The target cell for the radiometer was roughly one and a half times as large as that for the scatterometer. Data were obtained for various combinations of polarization and incidence angle. Upon examination of these data, it was discovered and anticipated, that soil moisture was an important variable that influenced the radiometer and scatterometer response. This lead to an evaluation of the influence of the soil moisture on the microwave response. Results from this evaluation are provided. Future fine resolution radar imaging systems may be carried in space to monitor various relatively transient phenomena on the surface--particularly those that are vegetation related. A potential application of data such as these is in finding whether a coarse resolution sensor such as the S-193 could be carried in conjunction with the fine-resolution sensor to correct levels of return for the effects of rainfall and consequent modifications in soil moisture over areas compatible with soil-moisture sensor resolution. Thus, in this case, the effect of the soil moisture on the average return from vegetation and other roughness of the surface can be monitored by determining how the return from apparently similar land use and vegetation categories differs in regions where the soil moisture differs.

35970 (CONF-7510172—P2, pp 1149-1158) **Analysis of the accuracy and cost-effectiveness of a cropland inventory utilizing remote sensing techniques.** Jensen, J.R.; Tinney, L.R.; Estes, J.E. (Univ. of California, Santa Barbara). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Cropland inventories utilizing high altitude and LANDSAT imagery were conducted in Kern County, California. It was found that in terms of the overall mean relative and absolute inventory accuracies, a LANDSAT multidate analysis yielded the most optimum results, i.e., 98% accuracy. The 1:125,000 CIR high altitude inventory is a serious alternative which can be very accurate (> or =to 97%) if imagery is available for a specific study area. The operational remote sensing cropland inventories documented in this study are considered cost-effective. When compared to conventional survey costs of $62 to 66 per 4050 hec (10,000 acres), the LANDSAT and high altitude inventories required only 3 to 5% of this amount, i.e., $1.97 to 2.98.

35971 (CONF-7510172—P2, pp 1159-1167) **Accuracy of forest mapping from Landsat computer compatible tapes.** Kalensky, Z.; Scherk, L.R. (Forest Management Inst., Ottawa). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

This paper summarizes the results of a two-year study on computerized processing of Landsat-1/MSS digital imagery undertaken jointly by the Forest Management Institute of the Canadian Forestry Service and Computing Devices Company, Ltd. The study examined the applicability of Landsat multispectral images recorded on computer compatible tapes (CCT) to forest mapping. A supervised classification was based on the Gaussian Maximum-Likelihood Decision Rule. The input imagery consisted of CCTs of Landsat scenes and their multidate combinations. Reported are accuracies and consistencies of computerized delineation and identification of the coniferous forest, deciduous forest and nonforest land as a function of the date of Landsat scene and their multidate combinations. Included also are results obtained from single- and multidate processing of Landsat imagery consisting of only two spectra bands: 5 (red) and 7 (second near-infrared) as well as those obtained when classifying one scene by IMAGE 100. The overall classification accuracies ranged from 67% to 81% for single-date imagery and were consistently above 80% for multidate combinations. New accuracy measures called class mapping accuracy and overall mapping accuracy were introduced in addition to the usual presentation of accuracy results in confusion tables. The mapping accuracies facilitate a direct comparison of classification results with their pictorial displays as on TV monitors, photographic images and maps.

35972 (CONF-7510172—P2, pp 1169-1178) **Measuring forage production of grazing units from Landsat MSS data.** Deering, D.W.; Rouse, J.W. Jr.; Haas, R.H.; Schell, J.A. (Texas A and M Univ., College Station). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The Great Plains Corridor project conducted by Texas A and M University as part of the NASA ERTS-1 (LANDSAT-1) investigations yielded results of considerable significance to rangeland management. The study emphasized the development of techniques for quantitative analysis of LANDSAT-1 MSS spectral reflectance data as quantitative indicators of the amount and seasonal condition of rangeland vegetation. Coincident satellite and ground truth data were collected during the growing seasons at ten test sites throughout the Great Plains of the central United States. The correlations between the MSS digital data, corrected for sun angle, and various ground parameters were determined. The theoretically derived normalized difference between the red and infrared bands was found to be useful for the quantitative measurement of herbaceous green biomass of natural vegetation systems. This led to the development of the Transformed Vegetation Index which incorporates the use of MSS Bands 7 and 5 values (TVI) or Bands 6 and 5 values (TVI6). A green biomass estimation model for the Throckmorton test site in north central Texas was developed using weather variables and the satellite derived TVI6 variable. These analyses of Throckmorton test site data indicate that green biomass can be estimated in increments of 250 to 300 kg/hectare with a 95% probability. The Throckmorton green biomass prediction model has been implemented in a CRT display system developed by the Remote Sensing Center's Data Analysis Laboratory. Green biomass in statistically significant increments is displayed for each pixel directly on a color TV display and pasture boundaries (grazing units) are superimposed. Average or total green biomass is computed for each grazing unit.

35973 (CONF-7510172—P2, pp 1189-1198) **Results from the Crop Identification Technology Assessment for Remote Sensing (CITARS) project.** Bizzell, R.M. (Johnson Space Center, Houston, TX); Hall, F.G.; Feiveson, A.H.; Bauer, M.E.; Davis, B.J.; Malila, W.A.; Rice, D.P. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The CITARS task design and objectives are reviewed and final results are presented, together with conclusions and recommendations. It was found that several factors had a significant effect on crop identification performance: crop maturity and site characteristics, which of several different single-date automatic data processing procedures was used for local recognition, nonlocal recognition, both with and without preprocessing for the extension of recognition signatures, and use of multidate (multitemporal) data. It also was found that classification accuracy for field center pixels was not a reliable indicator of proportion estimation performance for whole areas, that bias was present in proportion estimates, and that training data and procedures strongly influenced crop identification performance.

35974 (CONF-7510172—P2, pp 1199-1208) **Estimation of moisture content of forest fuels over the Southeastern U.S. using satellite data.** Waters, M. III. (National Environmental Satellite Service, Suitland, MD). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Synchronous meteorological satellite visual and infrared spin scan radiometer data were analyzed quantitatively for cloud cover and surface temperature for an area in the southeastern United States for 5 days in January 1975. Surface measures of air temperature and humidity at National Weather Service and military observation stations within the study area augmented the satellite data. The 1-hour timelag fuel moisture component of fuel model D in the National Fire Danger Rating System was estimated by: (1) using the satellite visual information for cloud cover, (2) air temperature blended with surface equivalent black body temperatures, and (3) an estimate of humidity made from ground stations. This automated estimate of 1-hour timelag fuel moisture was compared with measured values taken at Fire Danger Stations located in the study area. Differences between estimated and measured fields of fuel moisture were analyzed. Hourly estimates of the 1-hour timelag fuel moisture were computed for each day from 1000 to 1500 EST. Results of this study indicate that: 1-hour timelag fuel moisture can be estimated over forested areas with synchronous meteorological satellite data augmented with surface data for selected meteorological conditions, automated estimation of the 1-hour timelag fuel moisture can be made hourly, and distribution of cloud cover can be monitored and mapped each half-hour from satellite visual data to indicate surface isolation patterns.

35975 (CONF-7510172—P2, pp 1209-1218) **Landsat applications in Canadian forestry.** Sayn-Wittgenstein, L.; Wrightman, J.M. (Environment Canada, Ottawa). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

After an early exploratory phase of many experiments the use of LANDSAT data is now concentrated in a smaller number of applications. One of these applications is in integrated biophysical surveys where LANDSAT has probably found ready acceptance because it has not revolutionized procedures, but added a new perspective and plays a complementary role in an improved procedure. Other projects center on applications of Landsat in forest and vegetation surveys on large areas. most involve thematic maps but there is also a proposal to use a grid of samples to extract statistical information. These projects are all operational trials or feasibility studies: no one has staked the fate of large operational projects on success with Landsat data, but the option of reducing the role of alternatives to Landsat is left open. Further research would advance operational applications. The most significant operational applications of Landsat data have been in the mapping of broad forest cover types and recent forest fires. Experiments dealing with the charting of high water levels and tornado damage were also successful and satellite data would find practical application if the need should arise. Experimental successes in mapping cutover areas do not seem to have been translated into practice, perhaps because there is insufficient evidence that results obtained in one area are valid elsewhere. The writer is not aware of any operational forestry projects involving studies of phenologic events; the reasons are both technical limitations (frequency of coverage) and limited interest in this potentially major use of satellite data.

35976 (CONF-7510172—P2, pp 1235-1243) **Comparison of aerial passive gamma and passive microwave techniques for measurement of soil moisture.** Peck, E.L. (National Weather Service, Silver Spring, MD); Larson, L.W.; Farnsworth, R.K.; Dietrich, T.L. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Passive gamma and passive microwave radiation measurements have been recognized as having potential value for evaluation of mean areal soil moisture. Present procedures using point samples are slow and costly and the extrapolation from point to areal estimates is unreliable. Assessing the accuracy of these radiation techniques is difficult, primarily because there is no way of determining the true numerical value of the mean areal soil moisture. This paper presents a comparison of concurrent measurements of estimates of soil moisture from ground sampling and from measurements of passive microwave and passive gamma radiation made by aircraft. The Hydrologic Research Laboratory (HRL) of the National Weather Service (NWS), National Oceanic and Atmosphere Administration (NOAA), in cooperation with EG and G, Inc., has conducted extensive experiments since 1969 on the use of aerial gamma radiation surveys for measurement of the water equivalent of snow cover and of soil moisture.

35977 (CONF-7510172—P2, pp 1245-1253) **Measurements of snow cover over land with the Nimbus-5 microwave spectrometer.** Kuenzi, K.F. (Univ. of Bern); Staelin, D.H. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

From data obtained by the microwave spectrometer NEMS on board the Nimbus-5 satellite we have derived microwave signatures for snow covered land. The emissivity at 31.4 GHz is lower by about 10% than at 22.2 GHz, while the emissivities for uncovered land are approximately equal to 0.95 at both frequencies. Maps for snow cover over land are generated for the northern hemisphere and compared with data obtained by visible light imagery.

35978 (CONF-7510172—P2, pp 1255-1262) **Cost-effectiveness comparison of existing and Landsat-aided snow water content estimation systems.** Sharp, J.M.; Thomas, R.W. (Univ. of California, Berkeley). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

This study describes how LANDSAT imagery can be cost-effectively employed to augment an operational hydrologic model. Attention is directed toward the estimation of snow water content, a major predictor variable in the volumetric runoff forecasting model presently used by the California Department of Water Resources. A stratified double sampling scheme is supplemented with qualitative and quantitative analyses of existing operations to develop a comparison between the existing and satellite-aided approaches to snow water content estimation. Results show a decided advantage for the LANDSAT-aided approach.

35979 (CONF-7510172—P2, pp 1273-1284) **Remote sensing requirements as suggested by watershed model sensitivity analyses.**

Salomonson, V.V. (Goddard Space Flight Center, Greenbelt, MD); Ambaruch, R.; Rango, A.; Ormsby, J.P. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

A continuous simulation watershed model has been used to perform sensitivity analyses that provide guidance in defining remote sensing requirements for the monitoring of watershed features and processes. The results show that out of 26 input parameters having meaningful effects on simulated runoff, 6 appear to be obtainable with existing remote sensing techniques. Of these six parameters, 3 require the measurements of the areal extent of surface features (impervious areas, water bodies, and the extent of forested area), two require the descrimination of land use that can be related to overland flow roughness coefficient or the density of vegetation so as to estimate the magnitude of precipitation interception, and one parameter requires the measurement of distance to get the length over which overland flow typically occurs. Observational goals are also suggested for monitoring such fundamental watershed processes as precipitation, soil moisture, and evapotranspiration. A case study on the Patuxent River in Maryland shows that runoff simulation is improved if recent satellite land use observations are used as model inputs as opposed to less timely topographic map information.

35980 (CONF-7510172—P2, pp 1329) **Hydrological applications of microwave radiometry data.** Basharinov, A.E.; Borodin, L.F.; Shutko, A.M. (Inst. of Radioengineering and Electronics, Moscow). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The experimental data on passive microwave remote sensing of soil moisture, subsoil water and estimation the degree of water mineralization obtained from the aircraft in a wavelength range 0.8—30 cm are discussed in this report. The effective value of moisture content in the subsurface layer up to the depth of 10—15 cm can be determined from the measurements of brightness temperature contrasts at centimeter and decimeter wavelengths. The prolonged measurements of spatial--temporal brightness temperature variations fulfilled synchronously with direct soil moisture measurements on the ground made it able to obtain the representative quantitative data on the "brightness temperature--moisture content" dependence. The measurements were made in the vicinity of North-Crimean canal at irrigated and nonirrigated areas under the conditions of artificial and natural moistening. The obtained data indicated the slope of "brightness temperature--moisture content" dependence as 2—4 deg K/% moist for regions of bare ground. The vegetative cover decreases this value. The estimates of vertical moisture content profile can be realized by synchronousradiative measurements at centimeter and decimeter wavelengths. For this purpose the dependence of emissivity on the parameters of vertical profile takes into consideration. The expected sensitivity is about some percent of moisture variation per centimeter in the case of moisture content increase with depth.

35981 (CONF-7510172—P2, pp 1331-1345) **Applications of remote sensing for Corps of Engineers programs in New England.** McKim, H.L. (Army Cold Regions Research and Engineering Lab., Hanover, NH); Merry, C.J.; Cooper, S.; Anderson, D.M.; Gatto, L.W. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The utility of satellite, high altitude and low altitude aerial imagery is presently being critically evaluted by the Corps of Engineers. When the application has been demonstrated and is cost effective, it is used to update or augment conventional methods and procedures. Our most significant contribution to date has been to increase confidence limits by more accurately estimating parameters used in models. Within the last three years several new cooperative remote sensing programs addressing environmental and hydrologic problems have been implemented by the Cold Regions Research and Engineering Laboratory (CRREL) and the New England Division (NED) of the Corps of Engineers. These efforts have enabled state-of-the-art remote sensing techniques and newly developed satellite technology to be evaluated by field personnel. The initial objective of these programs was to determine the availability, type, scale, and resolution required. The second objective was to show how remote sensing methods can be utilized to augment or update conventional procedures. Imagery from the LANDSAT mission provided valuable information for site evaluation, definition of geologic lineations, and monitoring snow and ice accumulation and ablation. This information can have impact on the establishment of design criteria for new Corps facilities or on flood forecasting procedures.

35982 (CONF-7510172—P2, pp 1451-1456) **Canadian mapping use of Landsat imagery.** Fleming, E.A. (Topographical Survey, Ottawa). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Landsat imagery has been found to be a useful source of map revision information in the wilderness areas. Maps in these areas require revision when new roads, reservoirs or hydroelectric transmission lines are built. The location and extent of these features can be determined with sufficient accuracy for interim revision of 1 : 250,000 and 1 : 50,000 maps from the Landsat imagery. In addition the imagery has proved useful for detecting small Arctic Islands, relief shading and photomapping at a small scale.

35983 (ORNL/TM—6083) **Remeasurement of permanent vegetation plots in the Great Smoky Mountains National Park, Tennessee, USA, and the implications of climatic changes on vegetation. Environmental Sciences Division publication No. 1111.** Becking, R.W.; Olson, J.S. (Humboldt State Univ., Arcata, Calif. (USA). School of Natural Resources; Oak Ridge National Lab., Tenn. (USA)). Mar 1978. Contract W-7405-ENG-26. 117p. Dep. NTIS, PC A06/MF A01.

This report summarizes field work over two summers (1976 and 1977) to relocate, monument and reinventory permanent vegetation plots in the Great Smoky Mountains National Park. These plots were first established by the senior author and R.H. Whittaker in 1959-62. The inventory results are discussed in terms of vegetation changes in high-altitudinal forest ecosystems, in particular the spruce-fir forests, and the factors, climate shift and biotic and abiotic agents, bringing about vegetation change. A second aspect of the report summarizes experience and offers recommendations for establishment of permanent vegetation plots for the purpose of providing a monitoring tool with which to measure long-term ecological change.

35984 (ORO—4180-7) **Dynamics of the recovery of damaged tundra vegetation. Annual progress report.** Amundsen, C.C. (Tennessee Univ., Knoxville (USA)). 17 Mar 1978. Contract EY-76-S-05-4180. 8p. Dep. NTIS, PC A02/MF A01.

In the course of our continuing programs on the patterns and processes of disturbed landscape tundra revegetation, a study was made of natural revegetation by Elymus mollis Trin., the native dunegrass, in the Aleutian ecosystem. This species is the dominant member of the beach and dune community where it forms dense stands of high biomass. The species has also been observed, throughout our years of research, colonizing disturbed areas inland. These disturbances may be the bare surfaces of solifluction terraces or they may result from vegetation removal and scarring as the result of man's activities. Much of the damage resulted from World War II occupation. The surprising aspect of dunegrass colonization on such areas is the presumed depauperate nutritional supply and harsh climate the species encounters. Considering the success of this grass in natural colonization, it is suggested that with careful management, Elymus mollis could be shown to be useful in revegetation programs in the Aleutians.

35985 **Effect of pH on adsorption of copper, zinc, and cadmium from landfill leachate by clay minerals.** Frost, R.R.; Griffin, R.A. (Univ. of Illinois, Urbana). *J. Environ. Sci. Health, Part A;* **12**: No. 4-5, 139-156(1977).

The removal (exchange-adsorption plus precipitation) of Cu, Zn, and Cd from a municipal landfill leachate by kaolinite and montmorillonite was found to be dependent upon the pH and the ionic strength of the leachate. Sorption increased with increasing pH values and with increasing concentration of heavy metals. Montmorillonite sorbed approximately five times more heavy metal from solution than kaolinite. Precipitation contributed significantly to removal of Cu, Zn, and Cd from leachate above pH 6. The removal versus pH data (pH range 2 to 8) were used to construct adsorption isotherms at several pH values. Leachate isotherms were constructed at pH 5.0 and compared with pure aqueous solution isotherms for the same pH. The amount of adsorption at pH 5.0 from leachate was significantly lower than that from pure nitrate salt solutions because of competition from the other cations present in the leachate. Migration of heavy-metal ions through clay materials is predicted to be much greater in landfill leachate than in comparable aqueous solutions of lower ionic strength.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 35937

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 35940, 35941

35986 (BNWL—2100(Pt.5), pp 63-66) **Environmental policy analysis.** Jun 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 5. Control technology, overview, safety, and policy analysis.

Environmental issues that received special emphasis during FY-1976 and the transition quarter concerned the management of areas contaminated by Pu and other transuranics in soils, the control of releases of transuranics into the environment, and studies of acceptable levels of risk in the development and use of energy technologies.

35987 (IAEA-SM—222-10) **Instrument calibrations for environmental surveillance.** McLaughlin, J.E. (Department of Energy, New York (USA). Environmental Measurements Lab.). 1977. 18p. (CONF-771209—11). Dep. NTIS, PC A02/MF A01.

From IAEA symposium on national and international standardization of radiation dosimetry; Atlanta, GA, USA (5 Dec 1977).

Environmental radiation measurements are performed in the field to determine radionuclide composition, supplement calculated values of dose, and detect any changes from some normal value that can be attributed to a particular source. Instrument calibrations with laboratory sources, while necessary, are generally insufficient for these environmental applications. Account must be taken of the complex radiation field composition, low intensity and source-detector geometry, as well as of the instrument energy and angle responses. Transport calculations of the radiation field aid in the development of meaningful calibrations. Energy and angle spectra over the ground, the principal environmental source, have been calculated for different source distributions and gamma-ray energies, and verified experimentally. By determining detector responses to background components in this way, one can estimate any excess response to manmade sources. Operationally, consistency of field measurements with different instruments tends to assure good quality results. This paper described measurement methods developed for studies of natural, nuclear facilities and nuclear weapons radioactivity. Some of the methods were incorporated into a recent NCRP report, Environmental Radiation Measurements. Possible new monitoring problems are identified.

35988 **Particularities of distribution and migration of uranium in relation to metamorphic processes (on example of the Ukrainian Shield).** Belevtsev, Ya.N.; Zhukova, A.M. (AN Ukrainskoj SSR, Kiev. Inst. Geokhimii i Fiziki Mineralov). *Geol. Zh. (Russ. Ed.);* No. 5, 68-79(Sep 1976). (In Russian).

Archaean rocks of the Ukrainian Shield are granitized in their main mass (75%) and are presented by granulite and amphibolite metamorphous facies. Among them unshifted (anatectic) and shifted (rheomorphous) granites can be distinguished. Proterozoic rocks are presented by a facies of green schists. The uranium content (on the average of 4.1×10^{-4}%) in various metamorphous rocks has been studied on the basis of data of 3000 samples. It has been found that the uranium distribution in products of regional progressive metamorphism is caused by: intensity of metamorphous processes; uranium content in the primary substrate; the form of uranium in rocks. At high degrees of metamorphism up to 50 to 90% of uranium are carried away. In rocks of granulite facies which are improverished in uranium only accessor minerals remain its carriers. In rocks of lower metamorphous facies (green schists) uranium is to a considerable extent associated with rock minerals. Some increase in uranium content in rheomorphous, as a rule, potassium microclinic clays, is caused by the entry of uranium in alkaline solutions of predominantly potassium composition and then by solutions of predominantly sodium composition in the process of granitization.

35989 (LA-UR—78-645) **Plutonium, americium, and uranium in blow-sand mounds of safety-shot sites at the Nevada Test Site and the Tonopah Test Range.** Essington, E.H.; Gilbert, R.O.; Wireman, D.L.; Brady, D.N.; Fowler, E.B. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 73p. (CONF-770369—2). Dep. NTIS, PC A04/MF A01.

From NAEG Pu program report meeting; Las Vegas, NV, USA (2 Mar 1977).

Portions of document are illegible.

Blow-sand mounds or miniature sand dunes and mounds created by burrowing activities of animals were investigated by the Nevada Applied Ecology Group (NAEG) to determine the influence of mounds on plutonium, americium, and uranium distributions and inventories in areas of the Nevada Test Site and Tonopah Test Range. Those radioactive elements were added to the environment as a result of safety experiments of nuclear devices. Two studies were conducted. The first was to estimate the vertical distribution of americium in the blow-sand mounds and in the desert pavement surrounding the mounds. The second was to estimate the amount or concentration of the radioactive materials accumulated in the mound relative to the desert pavement. Five mound types were identified in which plutonium, americium, and uranium concentrations were measured: grass, shrub, complex, animal, and diffuse. The mount top (that portion above the surrounding land surface datum), the mound bottom (that portion below the mound to a depth of 5 cm below the surrounding land surface datum), and soil from the immediate area surrounding the mound were compared separately to determine if the radioactive elements had concentrated in the mounds. Results of the studies indicate that the mounds exhibit higher concentrations of plutonium, americium, and uranium than the immediate surrounding soil. The type of mound does not appear to have influenced the amount of the radioactive material found in the mound except for the animal mounds where the burrowing activities appear to have obliterated distribution patterns.

35990 (MLM—2495) **Mound Laboratory tritium environmental study: 1976—1977.** Kershner, C.J.; Rhinehammer, T.B. (Mound Facility, Miamisburg, Ohio (USA)). 10 Apr 1978. Contract EY-76-C-04-0053. 25p. Dep. NTIS, PC A02/MF A01.

In the course of an extensive investigation of tritium in the aquifer underlying the Mound Facility site, an unusual behavior was noted for a beta-emitting radionuclide contaminant present in the environs of the abandoned Miami-Erie Canal adjacent to the laboratory site. The soil contaminant was determined to be tritium, of which 90% was in the form of a relatively stable or bound species that was not readily exchangeable with the free water in the soil. (Bound-to-exchangeable transfer half-time was found to be approximately 3 yr.) The contamination was found to be concentrated within two feet of the surface in the center of the canal channel and near the Facility site drainage ditch and canal confluence. In order to characterize the contaminant and to assess its potential for reaching the aquifer, an analysis program and study were initiated in September 1976. The results and findings from the first phase of this work which was completed in February 1977 are the subject of this report.

35991 (UCLA—12-1134) **Transuranium element transport in agricultural systems (soil to food chain transfer of nuclear fuel cycle radionuclides). Annual progress report.** Wallace, A. (California Univ., Los Angeles (USA). Lab. of Nuclear Medicine and Radiation Biology). Oct 1977. 16p. NTIS.

Progress is reported on the following research projects: preparation of bibliography covering literature on plant uptake of transuranium elements; development of techniques for growth of agricultural crops in large containers that simulate field conditions; equipment for counting of alpha-emitting transuranium elements; studies on variability in concentration ratio of ^{241}Am under different environmental conditions; alpha radiation burn in bush beans exposed to ^{241}Am in solution; constancy of concentration ratio as a measure of plant uptake of ^{241}Am; growth of radishes in soil with and without DTPA, and radish peel as source of radionuclides; effects of varying levels of DTPA in loam soil on concentration ratio values; and a plant species (Atriplex hymenelytra--desert holly) with high C.R. values and search for other plants with high C.R. values. (HLW)

SOIL

REFER ALSO TO CITATION(S) 35370

TERRESTRIAL ECOSYSTEMS AND FOOD CHAINS

REFER ALSO TO CITATION(S) 36097

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 34416, 34419, 35366, 35367, 36004, 36026, 36131

35992 (CONF-7510172—P2, pp 705-724) **Preprocessing algorithms for the use of radiometric corrections and texture/spatial features in automatic land use classification.** Herzog, J.H.; Sturm, B. (Joint Research Center, Ispra, Italy). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Two preprocessing techniques have been applied to data generated by the NASA LANDSAT I satellite over the pre-alpine region of Northern Italy. In the first technique a transformation has successfully been applied to LANDSAT data to relate count rate to reflectance. The results have allowed a simple ratio classifier developed for earth based measurements to be applied to satellite data. In the second technique textural measurements have been applied to

space data to identify mixed picture elements (mixels). The mixel is the inevitable result of the spatial quantization of low resolution images. Pixels which vary greatly from their neighbors have a higher priority of being mixels than pixels which are similar to their neighbors. Mixels are shown to be representative of types of land use involving high texture. Texture measurements are useful in determining land usage. By screening data to eliminate mixels improved results are obtained in test site selection, classification, and cluster analysis.

35993 (CONF-7510172—P2, pp 793-802) **Improved resource use decisions and actions through remote sensing.** Boylan, M.; Enslin, W.R.; Hill-Rowley, R.; Vlasin, R.D. (Michigan State Univ., East Lansing). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The Michigan State University Remote Sensing Research Program continues to experiment with applications of remote sensing technology by assisting a variety of public agencies and private organizations in improving management decisions and actions, particularly those related to natural and cultural resources. Experience continues to emphasize important differences between most applications, distinctions which influence the selection of case studies, criteria for research design and methods, for time and budget allocations, and for the kinds of personnel to be utilized. From the applications completed during 1974—1975, eight case studies are described briefly with some important distinctions highlighted. These selections consist of: land value reappraisal for tax assessment purposes; optimizing agri-business processing plant locations; locating abandoned vehicles for removal and recycling; mapping of surface water bodies for rural fire-fighting units; timber management and utilization; highway corridor selection in a major river basin; land use inventory of Michigan's largest urban region.

35994 (CONF-7510172—P2, pp 835-844) **Use of remote sensing imagery and the PIOS system in land use studies at the Southern California Edison Company.** Crouch, R.G. (Southern California Edison Co., Rosemead); Dangermond, J.P. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Over the past three years the Southern California Edison Company (SCE) has developed and implemented an ongoing land use study program to assist in forecasting future electrical load growth and general facility planning. The technical elements of this program involve collection of land use data from high altitude imagery, automating this data using the PIOS system, conducting various area overlay and mapping studies, and incorporating this data into a generalized methodology for forecasting land use. In addition to a successful technical program, SCE has worked closely with three county agencies in definition of a mutually usable data inventory and in establishing a joint sponsorship program. As the SCE program continues, there may be additional areas of information system development that become both possible and cost effective. Some of these concepts are suggested herein.

35995 (CONF-7510172—P2, pp 857-865) **Survey of recent resource applications in Michigan.** Taylor, W.C. (Science Advisor to the Governor, Lansing, MI); Enslin, W.R.; Olson, C.E. Jr.; Sattinger, I.J. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Recent advances in the application of remote sensing techniques to Michigan problems have proceeded on a number of fronts. Michigan now has an extensive base of special remote sensing data, including color and color-IR photography of 75% of the state's land area, and high-resolution coverage of 3000 km of Michigan's mainland shoreline. LANDSAT and SKYLAB coverage of the entire state at various seasons is a valuable addition to the data base. Remote sensing is making a direct contribution to the implementation of emerging land-use programs and legislation by state and local public agencies. It is being extensively used in the preparation of statewide inventories of Michigan's land resources, based on a four-level classification system recently issued by the Office of Land Use of the Michigan Department of Natural Resources. Specific applications have been directed toward implementing a number of Michigan and Federal laws, including the Farmland and Open Space Preservation Act, the Soil Erosion and Sedimentation Control Act, the Shorelands Protection and Management Act, and the U.S. Coastal Zone Management Act. Through programs to encourage technology transfer, Michigan State University, The University of Michigan, and the Environmental Research Institute of Michigan are assisting Michigan-based government agencies and private organizations to make increasing use of remote sensing data for land-use regulation and management, shoreline protection, public acquisitions of critical environmental areas, wildlife habitat analysis, water quality monitoring, and many other resource management and protection functions.

35996 (CONF-7510172—P2, pp 873-877) **Louisiana comprehensive planning information system: compilation and utilization of the data base.** Schwertz, E.L. Jr. (Louisiana State Planning Office, Baton Rouge). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The development of a computer oriented planning information system, the Comprehensive Planning Information System (CPIS), by the Louisiana State Planning Office is presented. A brief description of the types of sociodemographic data stored in CPIS is covered. Considerable detail is devoted to the Land Use and Data Analysis (LUDA) Program of the U.S. Geological Survey (USGS) as it pertains to a cooperative agreement between the Louisiana State Planning Office and the Geography Program of USGS. Also reported is an account of the successful use made of the computerized land use data when merged with flood delineations obtained from LANDSAT satellite imagery to provide flood maps and tabulations. Computerization of soils association data for storage in CPIS and the potential for producing thematic soils limitation/suitability maps is presented. Examples of the use of data presently stored on CPIS, as well as projected uses for CPIS data, are listed.

35997 (RHO-LD—30) **Hanford Well Sediment Library Catalog.** Additon, M.K. (Atomics International Div., Richland, Wash. (USA). Rockwell Hanford Operations). Dec 1977. Contract EY-77-C-06-1030. 189p. Dep. NTIS, PC A09/MF A01.

The Hanford Well Sediment Library is a compilation of approximately 80,000 samples collected from 1,280 wells drilled on and around the Hanford Reservation since 1943. Although some wells are not represented, sediment samples from the majority of the wells have been collected providing a permanent record of the sediment types beneath the site. The Hanford Well Sediment Library is maintained by Rockwell Hanford Operations' Research Department for the benefit and use of all Hanford contractors.

35998 Modeling the impact of strip mining and reclamation processes on quality and quantity of water in mined areas: a review. Rogowski, A.S.; Pionke, H.B.; Broyan, J.G. (Northeast Watershed Research Center, University Park, PA). *J. Environ. Qual.;* 6: No. 3, 237-244(1977).

Current literature contains numerous studies of acid generation, neutralization, and transformation in strip-mine spoil materials, yet the rate-determining processes on the field scale are not well understood. Even less seems to be known about the spoil water flow, oxygen diffusion, surface runoff, erosion, evapotranspiration, and temperature distributions within the spoil banks. Most spoils seem to be principally considered from the standpoint of rapiid revegetation, use of amendments, and favorable placement of acid-producing materials. We conclude that hydrology of the spoil system could be simulated using standard modeling techniques. It also seems probable that experimentally obtained temperature and oxygen distributions could delineate acid-producing areas, assuming pyrite is not limiting, and is distributed evenly throughout the zone of interest.

ENVIRONMENTAL SCIENCES, AQUATIC

BASIC STUDIES

REFER ALSO TO CITATION(S) 34524, 35348, 35369, 35934, 35944, 35945, 35948, 35951, 35956, 35978, 35979, 35980, 36136

35999 (CONF-771231—2) **Temporally stratified sampling programs for estimation of fish impingement.** Kumar, K.D.; Griffith, J.S. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 24p. Dep. NTIS, PC A02/MF A01.

From 4. workshop on entrainment and impingement; Chicago, IL, USA (5 Dec 1977).

Impingement monitoring programs often expend valuable and limited resources and fail to provide a dependable estimate of either total annual impingement or those biological and physicochemical factors affecting impingement. In situations where initial monitoring has identified "problem" fish species and the periodicity of their impingement, intensive sampling during periods of high impingement will maximize information obtained. We use data gathered at two nuclear generating facilities in the southeastern United States to discuss techniques of designing such temporally stratified monitoring

programs and their benefits and drawbacks. Of the possible temporal patterns in environmental factors within a calendar year, differences among seasons are most influential in the impingement of freshwater fishes in the Southeast. Data on the threadfin shad (Dorosoma petenense) and the role of seasonal temperature changes are utilized as an example to demonstrate ways of most efficiently and accurately estimating impingement of the species.

36000 (CONF-7510172—P1, pp 131-138) **Satellite-interrogated data platforms in river and flood forecasting.** Flanders, A.F.; Schiesl, J.W. (National Weather Service, Silver Spring, MD). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Flood preparedness and day-to-day water management activities are dependent upon accurate knowledge of the state of the Nation's rivers. The River and Flood Forecast and Warning Service of the National Weather Service (NWS) is dependent upon reports from a network of nearly 7,000 river and rainfall stations. To speed up the collection of these reports the NWS has developed an Automated Hydrologic Observing System (AHOS) that provides great flexibility in the selection of the types of instruments that can use the system over the various forms of communications media such as telephone, radio, and satellite. Satellite communications are used where no reliable phone service exists. The data are transmitted from a remote hydrologic site through the Geostationary Operational Environmental Satellite (GOES) to a Command and Data Acquisition (CDA) Station at Wallops Island, Virginia, operated by the National Environmental Satellite Service (NESS) of the National Oceanic and Atmospheric Administration (NOAA). These data are then disseminated via NOAA communications to the River Forecast Centers (RFC's) and other users. This system holds promise for providing life-saving and economic benefits to the Nation through space age technology.

36001 (CONF-7510172—P1, pp 189-201) **Addressing the remote sensing data-information gap: overhead monitoring in New York's St. Lawrence River—Eastern Lake Ontario Coastal Zone.** Lillesand, T.M. (State Univ. of New York, Syracuse); Tyson, W.E. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Acceptance of remote sensing as a viable means of enhancing and expediting resource management and environmental monitoring has been, and continues to be, far from automatic. Despite substantive gains in remote sensing technology, a gap between the generation of data and conversion of same to information persists in "the real world" of coastal zone management. Included are results and conclusions drawn from applying remote sensing as an environmental monitoring tool in the management of New York's St. Lawrence-Eastern Lake Ontario Coastal Zone. A gamut of applications were demonstrated and the innate differences in roles of remote sensing researchers and "users" were crystallized. The contention is made that subsequent bridging of the data-information gap is predicated upon: (1) the use of remote sensing in the linkage and synthesis of land use, water quality and hydrologic data; (2) the provision for the proprietary unit as a primary input to land planning information systems; and (3) the definition of new parameters to measure and assess environmental quality in a form more directly amenable to remote sensing surveillance than existing quality indexes.

36002 (CONF-7510172—P2, pp 1231-1234) **Remote sensing as it applies to the International Ice Patrol.** Super, A.D.; Osmer, S.R. (Coast Guard International Ice Patrol, Governors Island, NY). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

On the evening of April 14, 1912, the SS TITANIC, on her maiden voyage, struck an iceberg near the Grand Banks of Newfoundland. With her subsequent sinking and tragic loss of life, a cry arose for a means of guarding this ice infested region. Since 1913 the U.S. Coast Guard has operated the International Ice Patrol Service, tasked with guarding the southeastern, southern, and southwestern regions of the Grand Banks, locating icebergs, and reporting the danger to mariners. With the aircraft replacing routine ship reconnaissance in 1945, numerous and various attempts have been made to utilize remote sensing techniques in detection and identification of icebergs on the fog-enshrouded Grand Banks. Remote reconnaissance is vital to the Ice Patrol because the Grand Banks, influenced both by the cold Labrador Current and the warm North Atlantic Current, is an area frequented by fog and fishing vessels. This fog, in addition to enshrouding the icebergs from mariners, often renders visual ice reconnaissance flights practically useless for extended durations. Thus, the pressing need for a sensor that has all-weather detecton and identification capabilities. This paper will briefly review experiments and evaluations conducted with airborne radiation thermometers (ART), side-looking airborne radars (SLAR), microwave radiometers, and satellite imagery. A brief look will also be taken at what future developments possibly await the Ice Patrol.

36003 (CONF-7510172—P2, pp 1263-1272) **Hydrologic studies in Alaska using NOAA VHRR imagery.** Seifert, R.D.; Kane, D.L.; Carlson, R.F. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Although several of the techiques discussed in this paper are not yet fully developed, some operational applications have been valuable in river flood forecasting. The synoptic nature and near real-time availability of the enhanced IR imagery, especially developed for hydrological application, is useful for monitoring snowmelt. The thermal accuracy of this enhanced imagery has been shown to be +-1°C by ground truth comparisons. In Alaska, the total coverage by VHRR imagery of large remote areas with little or no ground-based data acquisition makes the monitoring of environmental features a routine matter. VHRR visible imagery has been used unsuccessfully for two seasons to map snowfree areas as a function of time in several Alaskan River basins. A combination of the visible and enhanced IR imagery, made by overlaying the negatives of each and making a photographic print, also shows promise as a snowmapping tool. A preliminary study of the possibility of using reflected brightness for operational snowmapping with the visible channel imagery was also undertaken. Results are not conclusive, and more development of the techniques is necessary.

36004 (CONF-7510172—P2, pp 1285-1296) **Inland lakes water quality and watershed planning: an application of remote sensing technology.** Raney, R.K. (Environmental Research Inst. of Michigan, Ann Arbor); Wezernak, C.T.; Borton, T.; Haga, T.; Smeets, J. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The paper presents results of a research project designed to explore the impact of remote sensing and other information systems on public planning and policy decisions related to land development within the drainage basin of a small inland lake. The issue is one of maintaining water quality in the face of pressure to increase the cultural use of the watershed. The approach of the research was three-fold: to gather, interpret, and provide information regarding the issue to local decision makers; to assist in motivating a common problem recognition among the local people; and to withdraw from the local area, leaving behind sufficient technical resources to meet the needs of local initiatives to action, and to observe early phases of changed environmental decision-making. The problem has two aspects: the policy, planning, and decision-making structure; and the technical information needs relevant to the issue. The structure is disaggregate, involving some twenty-odd agencies, bureaus, and governments in the test area. The information needs are broad and technically demanding. In the context of this issue the remote sensing products proved their worth in two ways: as effective devices for capturing and holding the attention of non-technical people on technical aspects of local environment system; and as capable of providing information identifying critical features of the lake/watershed system that had been unknown before. Information derived from remote sensing was blended with many other pertinent sources.

36005 (CONF-7510172—P2, pp 1297-1309) **Remote sensing techniques applied to the study of fresh water springs in coastal areas of Southern Italy.** Guglielminetti, M.; Boltri, R.; Marino, C.M. (Idrotecneco S.p.A., S. Lorenzo in Campo, Italy). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

In September 1974, a large project of Remote Sensing applications was started in Italy with the participation of private and public Agencies. The aim of the project was the mapping of fresh water springs along the coast of Puglia (Southern Italy). Although affected by problems of water supply, this region discharges a large amount of fresh water into Adriatic Sea, mainly by means of karstic circulation. A certain number of submarine springs was historically known but no attempt has ever been made before in order to have a complete understanding of this phenomenon. The work involved more than 600 miles of R.S. flights utilizing both thermal I.R. and multispectral techniques. A dual channel I.R. thermal scanner and a cluster of four EL/70 Hasselblad (40 mm objective) were employed to detect both thermal contrast at sea surface and difference in light penetration in sea water due to fresh water upwelling. The thermal channels utilized were 4.5—5.5 and 9-11 μm (Daedalus 1230); the film filters combination were Trix-W 47, Trix-W 58, Kodak 2445-HF4. False colour I.R. was also used coupled with W 15 in order to

have a more detailed and complete knowledge of the land use along the coastal area.

36006 (CONF-7510172—P2, pp 1311-1318) **Quantitative evaluation of the minimum fresh water spring flow in the sea by means of thermal surveys.** Lechi, G.M.; Tincati, M. (Istituto per la Geofisica della Litosfera-C.N.R., Milan). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

In July 1974 there was carried out a research in order to establish a criterium for calculating the minimum amount of fresh water spring flow. The testsite chosen was in northern Sicily, along the shoreline of Cefalu, where a number of on-ground experiences were performed in the last few years. For this purpose a dual channel Daedalus scanner was employed, but only the $^{9}/_{11}$ micron band was considered for this quantitative approach. Owing to the optimum thermal contrast given by $^{9}/_{11}$ channel, the original information has been divided into selected levels in an analog way. Under proper working hypothesis, such as the regularity of the flow, the thermal equilibrium, the absence of wind and sea currents (or with well-known liminar coefficients), a relationship can be written which describes the whole thermal balance of the system. In other words we have to consider a well located fresh water flow as a beginning of the system while the sea is at the end, where the temperature is unperturbed. Because the fresh water is upwelling for a salinity contrast of 32‰ even if the fresh water temperature is some 10 degrees colder than salt water temperature, it is reasonable to consider only the heat balance at surface. Taking into account the heat radiated from the sea surface to the atmosphere, the heat exchanged by conductivity downward in the sea, both related to their own temperature, it was possible to evaluate the mass of fresh water coming into the sea per second.

36007 (CONF-7510172—P2, pp 1319-3128) **Applied remote sensing of the lower Atchafalaya Basin floodway.** Lewis, A.J.; Kim, S.T.; Wilson, R.T.; Monte, J.A.; McDonald, R.C. (Louisiana State Univ., Baton Rouge). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The Atchafalaya Basin, a federal floodway, has and continues to undergo rapid change. The future of the Basin is uncertain; however, before any land use policy was established a resource inventory was needed. The purpose of this study was to provide some of the data necessary for rational decision making. Remote sensing data (color, color infrared, and black and white infrared aerial film) were the primary data sources. Of the three types of aerial photographs, color infrared was judged the best for interpreting the various facets of the resource inventory. The results are presented in the form of five 1/62,500 scale maps covering vegetation, soils, water quality, canals and aquatics, and land use and a sequence of accretion maps from 1917 to 1972.

36008 (CONF-7510172—P2, pp 1347-1351) **Use of Landsat DCS in reservoir management and operations.** Cooper, S.; Horowitz, J.L. (Corps of Engineers, Waltham, MA). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The New England Division, Corps of Engineers (NED) has been participating in the NASA LANDSAT experiments to assess the possible future usefulness of orbiting satellites such as LANDSAT in the operation of its water resources systems used to control floods. Based on three year's experience with a 26 station network in New England, NED has found real time data collection by orbiting satellite relay to be both reliable and feasible. Orbiting satellite systems can be designed that are more flexible, easily maintained and less expensive than conventional ground-based means. NED endorses the institution of a satellite data collection system on a Corps-wide basis or a nationwide system with other Federal and State agencies, whether it be of the orbiting type with which we have experimented, or the geostationary kind for which evaluation is not yet available. Any operational satellite configuration should include ground receiving stations at all major user locales for direct receipt of satellite information, rather than the relay of data from NASA or some other agency. Therefore NED, with NASA support, has constructed and is now testing an inexpensive, semiautomatic and easily maintained ground receiving station as a follow-up to its original study.

36009 (CONF-7510172—P2, pp 1353-1360) **Corps of Engineers applications of Landsat digital data.** Williamson, A.N. (Army Engineer Waterways Experiment Station, Vicksburg, MI). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The U.S. Army Engineer Waterways Experiment Station has been studying data from Landsat-1 to determine the feasibility of detecting flow patterns, flushing actions of estuaries, and sediment and pollution dispersion. Techniques were developed to process Landsat computer-compatible-tape data, extract useful information, and present the information in several easily used forms. The automated processing techniques and concepts have broad applicability. This paper discusses how they have been applied to three Corps of Engineers studies.

36010 (CONF-7510172—P2, pp 1361-1366) **Some operational uses of satellite retransmission in Canada.** Haliday, R.A.; Reid, I.A. (Environment Canada, Ottawa). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

It is now possible through use of the data collection systems carried by satellites such as Landsat and GOES to obtain near real time water resources data from any location in Canada. These data have been used for flow and flood forecasting and to assist in the conduct of hydrometric surveys. Present programs will be continued and, likely, expanded, depending on the availability of suitable satellite systems.

36011 (CONF-7510172—P2, pp 1367-1376) **Operational applications of Satellite Snowcover Observations project.** Rango, A. (Goddard Space Flight Center, Greenbelt, MD). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The capability of the LANDSAT and NOAA satellites to accurately measure a snowcovered area on various size watersheds has been demonstrated by a number of investigators. Additionally, recent research has shown a highly significant statistical relationship between satellite-derived snowcovered area at the beginning of the snowmelt period and seasonal runoff. The decision was made, therefore, to test the results of several satellite snowcovered area studies in an Applications Systems Verification Test (ASVT) Program where quasioperational evaluations of total technical capability are performed. The objective of these ASVT's is to provide all the information necessary for a potential user to make effective decisions concerning the implementation of the new remote sensing technology in an operational applications system. The ongoing Operational Applications of Satellite Snowcover Observations (OASSO) Project became part of the ASVT Program in July 1975, and is described in this paper. In cooperation with various operational water management agencies in Arizona, California, Colorado, and Oregon, the OASSO Project is scheduled for completion in September 1978.

36012 (CONF-7510172—P2, pp 1377-1404) **Great Lakes all-weather ice information system.** Schertler, R.J.; Mueller, R.A.; Jirberg, R.J.; Cooper, D.W.; Chase, T.; Heighway, J.E.; Holmes, A.D.; Gedney, R.T.; Mark, H. (Lewis Research Center, Cleveland). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

This paper describes an all-weather ice information system developed by the NASA Lewis Research Center as part of the twelve federal agency Great Lakes Winter Navigation Program for which the U.S. Army Corps of Engineers is lead agency. This system utilizes an X-band Side-Looking-Airborne-Radar (SLAR) for determining type, location, and aerial distribution of the ice cover in the Great Lakes and an airborne, S-band, short pulse radar for obtaining ice thickness. The SLAR system is currently mounted aboard a U.S. Coast Guard C-130B aircraft. Digitized SLAR data are relayed in real-time via the NOAA-GOES-1 satellite in geosynchronous orbit to the U.S. Coast Guard Ice Center in Cleveland, Ohio. SLAR images along with hand-drawn interpretative ice charts for various winter shipping areas in the Great Lakes are broadcast to facsimile recorders aboard Great Lakes vessels via the MARAD marine VHF-FM radio network to assist such vessels in navigating both through and around the ice. The operational aspects of this Ice Information System are being demonstrated by NASA, U.S. Coast Guard, and NOAA/National Weather Service. Results from the 1974—75 winter season demonstrated the ability of this system to provide all-weather ice information to shippers in a timely manner.

36013 (CONF-7510172—P2, pp 1405-1414) **Current status and quality of global operational sea surface temperatures from satellite infrared data.** Brower, R.L.; Pichel, W.G.; Walton, C.C.; Signore, T.L. (National Environmental Satellite Service, Suitland, MD). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The National Environmental Satellite Service (NESS) has developed a sea surface temperature observatory system to support the operational, research and development needs of oceanographers and environmental scientists. The program provides daily global surveillance of the ocean's surface temperature structure. Sea surface temperature values are derived from Scanning Radiometer infrared data from the NOAA series of polar orbiting satellites. The technique used to obtain these temperatures is the fully automated computer procedure GOSSTCOMP (Global Operational Sea Surface Temperature Computation). Surface temperature retrievals are derived by statistical analysis and quality control techniques applied to instrument measurements within roughly 100 km square areas. Retrieval temperatures are corrected for the effects of atmospheric attenuation by using time coincident measurements derived from a Vertical Temperature Profile Radiometer (VTPR). The basic product obtained from the model is a daily set of 5,000 to 7,000 observations of sea surface temperature over the oceans of both hemispheres. The GOSSTCOMP procedure has produced a high level of dependability for product delivery. During the period July 1974—June 1975 an operational success rate of 97% was maintained. During that period 1,861,183 observations were produced with a global daily mean difference from ship reports ranging from −.92°C to +.39°C. Procedures used to obtain sea surface temperatures are constantly being improved as advances are made in retrieval, atmospheric attenuation, and quality control techniques. A major improvement in the accuracy of GOSSTCOMP produced sea surface temperatures is expected in 1978 with the next generation of polar orbiting satellites, the TIROS-N series.

36014 (CONF-7510172—P2, pp 1415-1426) **Infrared imagery analysis of the surface and near-surface hydrology of a gas storage field in Garrett County, Maryland.** Fisher, W. Jr. (HRB-Singer, Inc., State College, PA). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Expansion planning, associated with a storage field scheduled for the drilling of four additional wells, identified the need for an assessment of surface and near-surface water features. Previous drilling problems developed due to encountering fractured zones. The possible diversion of ground water supplies and the potential pollution of ground and surface waters were also factors of main concern. The objective of the effort described herein was to identify, locate, and report the fracture traces, the surface, and the near-surface water over the gas storage field thereby delineating those areas where drilling would not be advisable. This was accomplished by the utilization of airborne thermal infrared remote sensing and existing hydrogeologic information. The combination of this information led to the development of three basic maps to be used to guide the location of drillholes. The first of these was a fracture trace location map. The fracture traces were identified and plotted directly from the infrared imagery. Interest in the fracture traces relative to the drilling operations were in delineating them to avoid drilling near them because they may be high-yield water zones or cause the loss of drill fluid circulation. The second map was a hydrologic feature map including springs, seeps, ponds, and streams. From the map of these features and application of a knowledge of the local geology, it was possible to infer the location of areas of shallow water tables. The third map was a ground water contour map developed from reported water well levels and data from the hydrologic feature.

36015 (CONF-7510172—P2, pp 1447-1450) **Shorelands management using remote sensing techniques.** Dooley, J.P.; Clinton, F.A.; Jannereth, M.R. (Michigan Dept. of Natural Resources, Lansing). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The Michigan Shorelands Protection and Management Act was presented as the impetus for surveying the Great Lakes shoreline to identify areas having significant erosion problems. Setback distances from the bluffline are required on all undeveloped, unplatted high risk erosion shoreline for the protection of permanent structures. Aerial photographic coverage of the shoreline, both historic and modern are discussed as the most cost effective way of determining actual recession of the bluffline. This information is then used to calculate the setback distances for each area. Unique problems arising in the use of aerial photography in measuring changes in the shoreline environment as well as photogrammetric problems common to all areas are discussed in relation to the need for recession rates to administer the Shorelands Act.

CHEMICALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 34408, 34411, 34415, 34416, 34417, 34418, 34519, 35937, 35938, 35944, 35948, 35950, 36086, 36086, 36136

36016 (CONF-7510172—P1, pp 3-16) **Utilization of remote sensing techniques for U.S. Coast Guard missions.** Woolever, G.F. (Coast Guard, Washington, DC); Kidd, L.A.; Welsh, J.P.; McIntosh, J.A.; Farmer, L.D. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The U.S. Coast Guard is implementing a variety of remote sensing techniques in the performance of several missions, such as for pollution surveillance, ice classification, iceberg detection and classification, vessel traffic system development, and search and rescue. Recent activities are briefly described, including examples of imagery and forecasts for future applications.

36017 (CONF-7510172—P1, pp 203-222) **Remote sensing of luminescing environmental pollutants using a Fraunhofer line discriminator (FLD).** Watson, R.D.; Hemphill, W.R.; Bigelow, R.C. (Geological Survey, Flagstaff, AZ). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

A redesigned Fraunhofer Line Discriminator (FLD) tested in both ground-based and airborne experiments for 18 months (1974-75) to determine its ability to detect luminescing pollutants, has demonstrated the capability of operating at selected Fraunhofer wavelengths throughout the visible spectrum, with a sensitivity sufficient to detect 0.25 parts per billion rhodamine WT dye in 0.5 m depth of water at 20°C. The instrument has been used to detect and monitor several sources of pollution including oil spills and seeps, sewage effluent, phosphate processing effluent, and paper mill effluent. Selected luminescent dyes that could be used as tracers in pollutant transport studies were monitored in real time from helicopter platform. A comparison of laboratory measurements used to predict the detectivity of a given pollutant and actual field measurements with the FLD demonstrates that the laboratory technique can be used reliably to predict the detectivity of these materials in the field with the FLD.

36018 (CONF-7510172—P1, pp 223-230) **Detection and analysis for water surface covered with oil film.** Matsui, M. (Kyoto Inst. of Tech.); Tsutsumi, S.; Takagi, T. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The additive background radiation from all materials other than the targets to be detected presents a serious problem to the passive infrared sensors. This report describes both the scanning angle dependence of the spatial radiance distribution over the sea surface and the relationship of the sea surface radiance versus the thickness of oil film by which the sea surface is covered uniformly, operating in the spectral region of 10 to 13μm.

36019 (CONF-7510172—P1, pp 231-241) **New concept for the remote measurement of oil fluorescence conversion efficiency.** Kung, R.T.V.; Itzkan, I. (Avco Everett Research Lab., Inc., Everett, MA). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

To achieve a factor of two accuracy in the absolute fluorescence conversion efficiency, eta/sub f/, the following conditions should be satisfied. The film thickness should be greater than $^1/_2\mu$m. Optical depth of the film greater than 0.05 (Δ/sub r/ less than or equal to 0.95) is required. The seawater attenuation coefficient should be less than 1.0 m^{-1} at some location along an aircraft flight path. Background seawater fluorescence efficiency should be less than the equivalent thick film oil fluorescence conversion efficiency. These are not stringent limitations to the usefulness of the present technique. An example of two oils which are spectrally similar to within a factor of two but can be distinguished on an absolute basis is shown. This method affords the absolute remote measurement of the oil fluorescences conversion efficiency which is an important characteristic in oil identification.

36020 (CONF-7510172—P1, pp 243-250) **Radar observations of controlled oilspills.** van Kuilenburg, J. (NIWARS, Holland). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

A report is given of studies and experiments concerning the radar detection of oilslicks at the sea surface. From scatterometer observations of oilslicks in a wavetank it is concluded that oil is always detectable, but also that oil-type and thickness are of little influence on the radarecho. The radar observation of the damping of water waves which travel into the polluted area is proposed as an indicator of the physical oil properties. A radar operating in the VV-polarisation mode is shown to be optimal because of the strength of the radarecho, the observed contrast and the low noise. However, experiments using a SLAR operating in the HH-mode showed this polarisation combination to perform well enough for the purpose of oil detection. In general the conclusion is drawn that the SLAR performs well for detection and mapping of oilspills but that other sensors are needed for classification and quantification of oilspills.

36021 (CONF-7510172—P1, pp 251-252) **Remote sensing of oil on the sea surface.** Kondratev, K.Ya.; Rabinovich, Yu.I.; Melentev, V.V.; Shulgina, E.M. (Hydrometeorological Service, Leningrad). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The increasing pollution of the aquatic regions is a consequence of continuous growth of industry. Oil and oil products are the most serious sources of sea and ocean pollution. Together with elaboration of the methods of struggle against the sea- and ocean surface pollution, the development of techniques for remote sensing of this pollution, with the aim of its timely localization, is quite essential. The paper considers the possibility of microwave remote sensing of the ocean surface pollution by oil products. To calculate the oil-film covered sea-surface microwave emission, the data on the oil dielectric constants obtained over the range of 2.5 to 3.4 cm, have been used. The real part of the oil dielectric constant does not practically change over this range (2.24 to 2.27), but the imaginary part of the dielectric constant increases with decrease of frequency (0.0126 to 0.0150). Calculations of the "oil product-water" system microwave emission are performed over the wavelength region of 1.6 to 3 cm at the temperature of 20°C and salinity of 40‰. The results of calculations have shown that for the horizontal polarization, the emissivity contrasts due to the presence of oil products on the sea surface are greater than for the vertical polarization. However, they do not exceed the analogous contrasts at nadir observations. The emissivity contrasts can reach 0.06, which corresponds to radiobrightness temperature variation by approximately 20°K. The microwave emission dependences on the oil product type and age, and on film thickness are considered in this paper; recommendations are made on the wavelength selection which is optimum for remote sensing of the sea-surface pollution.

36022 (CONF-7510172—P1, pp 253) **Los Angeles Harbor field investigation of oil and background luminescence signatures.** Gross, H.G. (McDonnell Douglas Astronautics Co., Huntington Beach, CA). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

A field investigation of uv laser (pulsed and CW) induced luminescence signatures of site water at five scattered sites in Los Angeles Harbor and one in its principal source of inland inflow, Dominguez Channel, was achieved. The signatures are similar, indicating dominance by one or more common constituents. The peak at about 4500A and shape of the signature suggest dominance by heavier aromatics, probably by oil and grease, among the principal pollutants. Gas chromatograph-mass spectrometer analyses of site samples show light and heavy constituents, some of which are aromatics. Further work is necessary to relate luminescence signatures to composition. Luminescence signatures of light, medium and heavy oils were established as measurable against the strong water luminescence background. Thin oil films of iridescent thickness, however, can be dominated by the water signature. Reflectance signatures of oil films on water indicate a luminescent component due to sky scattered daylight and direct sun uv irradiation. Multispectral photography provided a few examples of site supportive information.

36023 (CONF-7510172—P2, pp 845-855) **Environmental impact assessment for areawide wastewater treatment and management plans.** Goehring, D.R. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The environmental impacts of an areawide waste treatment and management plan are broad, and their assessment must include all physical, social, and economic aspects of the human environment. Assessing impacts is seen as a continuous process to collect technical and non-technical data and, using the data, to identify, measure and evaluate the impacts of planning and engineering decisions throughout the course of the project. One specific use of the process is to identify community values which determine the capability and suitability of land for development. Assessing environmental impacts not only satisfies Federal (NEPA) requirements but also identifies the position that water quality goals occupies in the entire mix of community goals and objectives.

36024 Hydrocarbons in cores of northwestern Atlantic coastal and continental margin sediments. Farrington, J.W.; Frew, N.M.; Gschwend, P.M.; Tripp, B.W. (Woods Hole Oceanographic Institution, MA). *Estuarine Coastal Mar. Sci.;* **5**: No. 6, 793-808(Nov 1977).

The concentrations and composition of hydrocarbons in sections from a ^{210}Pb dated core from Buzzards Bay, Massachusetts are reported. Terrigenous n-alkane concentrations remain constant throughout the 62 cm and 195 years sampled. Gas chromatographic analysis on SCOT columns revealed an unresolved complex mixture of alkanes and cycloalkanes which decreases in concentration with increasing depth. Phenanthrene and C_1 and C_2 substituted phenanthrene concentrations also decreased with increasing depth and the relative abundance of C_1 and C_2 homologs compared to phenanthrene suggest a pyrolytic origin for these aromatic hydrocarbons. The various sources of hydrocarbons in surface sediments and the processes which could govern their distribution are discussed. The most likely source of the phenanthrenes and the unresolved complex mixture of alkanes and cycloalkanes in the upper core sections circa 1900 to the present seems to be urban air fallout. A depth distribution of alkanes and cycloalkanes similar to the Buzzards Bay core was found for a second area of Buzzards Bay and for cores from sediments of the Gulf of Maine and Hudson Canyon. Two C_{25} cycloalkenes were identified as major hydrocarbons in the sediments. Their concentrations decrease with increasing depth in the cores. Mass spectra of these compounds and their hydrogenation products are reported.

36025 Determination of mercury in fish from rivers and lakes in Hungary by atomic absorption technique. Gergely, A.; Soos, K.; Erdelyi, L.; Cieleszky, V. (Inst. of Nutrition, Budapest). *Toxicology;* **7**: No. 3, 349-355(Jun 1977).

In 1975, in cooperation with 8 County Hygienic Stations, total mercury content in fish from rivers and lakes in Hungary was measured. The mercury content in fish muscle-tissue from 164 fish samples averaged 0.36 mg/kg. Average levels in different fish species ranged from 0.10 to 0.57 mg/kg. The amount of mercury in fish from rivers and lakes, with the exception of the Danube, was, in general, lower than the tolerance level (0.50 mg/kg) as adopted in many countries. Mercury levels in fish from Lake Balaton did not amount to more than 0.30 mg/kg. The circulating cold vapor atomic absorption method was used to determine the mercury content in the fish samples.

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

REFER ALSO TO CITATION(S) 35938, 35940, 35941, 35942, 35990, 36086

SITE RESOURCE AND USE STUDIES

REFER ALSO TO CITATION(S) 36004

ENVIRONMENTAL-SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

SOCIAL AND ECONOMIC STUDIES

REFER ALSO TO CITATION(S) 34488, 35356, 35359, 35361, 35362, 35364, 35994, 35996, 36023

36026 Arid zone development: potentialities and problems. Mundlak, Y.; Singer, S.F. (eds.). Cambridge, MA; Ballinger Publishing Co. (1977). 412p. (CONF-7510175—). .

From Symposium on arid zone development; Jerusalem, Israel (Oct 1975).

Twenty papers presented at this meeting discuss various aspects of the development potential of arid lands, water resources and use in arid lands, land and water utilization for agriculture and industry, the possible impact of solar energy on developments in arid

regions, and the economic and social implications of arid zone development.

ASSESSMENT OF ENERGY TECHNOLOGIES

REFER ALSO TO CITATION(S) 35361, 35362, 35364, 35369

36027 (BNWL—2100(Pt.5)) **Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 5. Control technology, overview, safety, and policy analysis.** Bair, W.J. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jun 1977. Contract EY-76-C-06-1830. 87p. Dep. NTIS, PC A05/MF A01.

Separate abstracts were prepared on four sections of this report that describes research programs at BNWL related to pollution control technology for the development of energy sources.

36028 (BNWL—2100(Pt.5), pp 29-50) **Technology overview.** Jun 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 5. Control technology, overview, safety, and policy analysis.

The Integrated Assessment Program, funded by the ERDA Division of Technology Overview, is the mechanism by which health, environmental, social, economic and institutional factors are combined into a form useful for energy planning and decision making. This program selectively combines information about effects of alternative energy technologies (such as waste releases, land and water use, and social effects) to produce broad-based assessments of the advantages and disadvantages of energy and conservation options. As a corollary, needs for further research, development, and technology transfer are identified. The program is focused on four interrelated activities: supporting systems analysis to develop and improve methods for use in assessing and comparing impacts of energy and conservation options; integrated technological impact assessment, applying these methods to help select technologies for development that are safe, clean, and environmentally acceptable; regional comparative assessments, applying the results of the technological impact assessments to identification of regional energy strategies; and a regional outreach effort to assist regional and state agencies in their energy planning programs.

BIOMEDICAL SCIENCES, BASIC STUDIES

36029 (FMI—44) **Annual report, 1977.** Lanzl, E.F. (ed.). (Franklin McLean Memorial Research Inst., Chicago, Ill. (USA)). 1977. Contract EY-76-C-02-0069. 63p. Dep. NTIS, PC A04/MF A01.

Separate abstracts were prepared for four sections of this report.

BEHAVIORAL BIOLOGY

36030 Energetics of r- vs. K-selection in two African strains of Aedes aegypti. Schlosser, I.J. (Illinois State Univ., Normal); Buffington, J.D. *Ann. Entomol. Soc. Am.;* **70**: No. 2, 196-202(15 Mar 1977).

Two strains of the mosquito Aedes aegypti obtained in Tanzania in 1971 from a village habitat (House) and a feral habitat (Bamboo) only 100 meters apart demonstrated differences in both their physiological and population ecology, suggesting some genetic isolation between them. Their population attributes indicate that House is more r-selected and Bamboo is more K-selected. Measurements of respiration indicate that despite a number of differences between the strains, the energy cost of the immature part of the life cycle is essentially the same for both of them. However each strain has adopted a different strategy in using this energy: in Bamboo more is incorporated into biomass, while in House more goes to maintaining the life cycle. The immature life cycle proceeds more rapidly in House. These observations suggest a generalization that for similar organisms differing life table strategies may be employed but only to the extent that an apparently definite energy cost is paid.

BIOCHEMISTRY

REFER ALSO TO CITATION(S) 36059, 36060, 36110

36031 Testosterone-estradiol-binding globulin in patients with Turner's syndrome: effects of estrogens and acute growth hormone administration. Bergink, E.W.; Wolf, D.L.; Wittliff, J.L.; Bruining, G.J.; Bryson, M.F.; Forbes, G.B. (Univ. of Rochester Medical Center, NY). *J. Clin. Endocrinol. Metab.;* **42**: No. 6, 1018-1023(Jun 1976).

The TeBG activity of plasma from patients with Turner's syndrome was measured quantitatively using polyacrylamide gel electrophoresis. Human growth hormone administration did not significantly change the plasma TeBG levels. However, oral replacement therapy with estrogens elevated plasma TeBG within 3 days; after 9 days these levels reached a maximum of three- to four-fold greater than that observed at a time prior to therapy.

36032 (FMI—44, pp 10-17) **Biomedical studies.** 1977.

In Annual report, 1977.

Brief summaries of biomedical studies presented include: enzyme regulation of complex metabolic pathways in normal and neoplastic cells; the purification of glutamine synthetase from partially purified extracts of rat hepatomas, host rat livers, and control rat livers for comparison of properties for the regulation of protein metabolism; chromosomal changes in patients with leukemia; abdominal lymph node involvement and response to radiotherapy and chemotherapy in patients with Hodgkin disease; and the ultrastructure and immune reactions of leukemic blood cells.

36033 (FMI—44, pp 18-27) **Biochemistry, cell and molecular biology.** 1977.

In Annual report, 1977.

Methods are described for the purification of human erythropoietin for use in studies of effects on human bone marrow cells in cultures. Human alpha-fetoprotein isolated from body fluids of patients with tumors of the liver or stomach, as well as fetal liver, were subjected to gel electrophorosis and immunoelectrophorosis for quantitation of molecular species and immunosuppressive potency. Progress is reported on the mapping of yeast mitochondrial DNA, the isolation of messenger RNA involved in the biosynthesis of muscle protein, and the compositional and sequence analysis of protein biosynthesis. A bioassay system for coal tar polycyclid aromatic hydrocarbons was tested that is based on the capacity of toxic substances to inhibit bacteriophage replication in Escherichia coli.

36034 Tissue enzyme changes in parabiotic rats with subcutaneous lymphoma or fibrosarcoma. Herzfeld, A.; Greengard, O.; Warren, S. (Harvard Medical School, Boston). *J. Natl. Cancer Inst.;* **60**: No. 4, 825-828(Apr 1978).

A solid lymphoma implanted into normal inbred Kx rats and one partner of parabiotic pairs caused appreciable decreases in hepatic ornithine aminotransferase and arginase about a week earlier (4 to 6 days after implantation) in single hosts than in parabiotic hosts. By 18 to 21 days significant decreases in both enzymes were apparent in the host partner also. The hepatic thymidine kinase showed a fivefold elevation in single hosts 4 days after implantation; by 14 days its levels were about 200 times above normal and had also risen in the parabiotic hosts (20-fold) and host partners (fourfold). Implantation of fibrosarcoma caused qualitatively similar but generally less pronounced changes in these three enzymes in livers of single hosts, parabiotic hosts, and host partners. The splenic thymidine kinase 14 days after implantation was increased from control levels of about 3 U/g to 50.6, 44.8, and 13.5 U/g in single hosts, parabiotic hosts, and host partners, respectively. At later stages, 17 to 20 days after implantation of the lymphoma, appreciable amounts of thymidine kinase appeared in the plasma: The units of activity per milliliter were 6.2 in single hosts, 0.79 in parabiotic hosts, and 0.55 in host partners (control <0.05). Our observations on the changes in hepatic and splenic enzymes in parabiotic rats suggest that effects of neoplasms on distant host tissues are mediated by humoral factors. The less pronounced responses in parabiotic than in single hosts indicate that the tumor-free partner affords some "protection" against these systemic effects.

36035 Effect of gene dosage on expression of mitochondrial malic enzyme activity in the mouse. *Nature (London);* **271**: 748-750(23 Feb 1978).

The level of expression in animals heterozygous for lethal c-locus mutations (c/sup ch//c*) with that of their c/sup ch//c/sup ch/ littermates were compared in order to clarify the precise quantitative effect of gene dosage on the expression of enzyme activity in this system. We have shown that enzyme activity is linearly related to gene dosage in both heart and kidney. The data demonstrate that four out of seven complementation groups of c* mutations are most simply explained as deficiencies that include the structural gene. The specific activity of MOD-2 was determined in mitochondrial pellets prepared from homogenates of whole hearts. We concluded that valid quantitative comparisons of MOD-2 activity could be made between mitochrondial fractions isolated from the hearts of c/sup ch//c/sup ch/ and c/sup ch//c* mice.

36036 In vitro translation of the two RNAs of nodamura virus, a novel mammalian virus with a divided genome. Newman, J.F.E.; Matthews, T.; Omilianowski, D.R.; Salerno, T.; Kaesberg, P.;

Rueckert, R. (Univ. of Wisconsin, Madison). *J. Virol.;* **25**: No. 1, 78-85(Jan 1978).

Nodamura virus is a small ribovirus containing two RNA molecules. Both RNAs were found to be active messengers for protein synthesis in cell-free extracts prepared from wheat embryo or HeLa cells. RNA 2 directed synthesis of a 43,000-dalton product, p43, whose tryptic fingerprint was similar to that of the major viral coat protein, vp40 (molecular weight, 40,000). Though p43 appears to be a precursor of vp40, processing did not occur in the cell-free extracts. RNA 1 directed synthesis of a 105,000-dalton protein, p105. Its tryptic fingerprint revealed no evidence of coat protein sequences. Hence, the two RNAs represent genes with few, if any, redundant coding sequences.

36037 Spectrophotometric assay of catalase with perborate as substrate. Thomson, J.R.; Nance, S.L.; Tollaksen, S.L. (Argonne National Lab., IL). *Proc. Soc. Exp. Biol. Med.;* **157**: No. 1, 33-35(Jan 1978).

A spectrophotometric assay for catalase in mouse liver fractions has been developed in which sodium perborate, rather than hydrogen peroxide, is used as the substrate. The method is convenient, rapid, and readily adapted to the measurement of catalase in subcellular fractions.

36038 Glycoprotein synthesis in plants. II. Structure of the mannolipid intermediate. Delmer, D.P.; Kulow, C.; Ericson, M.C. (Michigan State Univ., East Lansing). *Plant Physiol.;* **61**: No. 1, 25-29(Jan 1978).

This paper reports the purification and structural determination of the mannolipid shown previously (Ericson and Delmer 1977 Plant Physiol 59: 341-347) to serve as an intermediate in glycoprotein synthesis in cotyledons of Phaseolus vulgaris. The mannolipid was purified by chromatography in organic solvents on diethylaminoethyl-cellulose, followed by repeated steps of deacylation and rechromatography on Sephadex LH-20. Binding and elution behavior on diethylaminoethylcellulose was consistent with the presence of a monophosphate residue. Lability of the mannolipid to mild acid treatment as well as its resistance to hot phenol treatment or catalytic hydrogenation are consistent with the structure of a polyprenol having a saturated α-residue. After methanolysis, the chloroform-methanol-soluble portion of the mannolipid was analyzed by mass spectrometry. The fragmentation pattern obtained was nearly identical to that obtained from standard dolicholphosphate. An intense ion at m/e 69 represented the ω-terminal isoprenoid residue, the repeating fragments separated by 68 mass units were observed up to m/e of >1200. All evidence supports the conclusion that the mannolipid is dolichol-monophosphate-mannose and thus provides further support for the concept that the processes involved in the glycosylation of protein in higher plants are similar to those known to occur in the animal kingdom.

36039 No effect of 5-fluorouracil on the properties of purified α-amylase from barley half-seeds. Rodaway, S.J.; Kende, H. (Michigan State Univ., East Lansing). *Plant Physiol.;* **61**: No. 1, 1-6(Jan 1978).

Amylase has been purified from de-embryonated seeds of barley (Horedeum vulgare L. cv. Betzes) which have been incubated on 10^{-6}M gibberellic acid (GA_3) following 3 days of imbibition in buffer. Incubation of the half-seeds in up to 10^{-2} M 5-fluorouracil (5-FU) during the entire incubation period, including imbibition, had no effect on any of the following characteristics of purified α-amylase: thermal stability in the absence of calcium, molecular weight of the enzyme, isozyme composition, specific activity, or the amount of α-amylase synthesized by the aleurone tissue. The synthesis of rRNA and tRNA was strongly inhibited by 5-FU, indicating that the analog had entered the aleurone cells. These results are not in agreement with those of Carlson (Nature New Biology 237: 39-41 [1972]) who found that treatment of barley aleurone with 10^{-4} M 5-FU to the addition of GA_3 resulted in decreased thermal stability of GA_3-induced α-amylase and who interpreted this as evidence that the mRNA for α-amylase was synthesized during the imbibition of the aleurone tissue and independently of gibberellin action. Results of the present experiments indicate that the thermal stability of highly purified α-amylase is not altered by treatment of barley half-seeds with 5-FU, and that 5-FU cannot be used as a probe to examine the timing of α-amylase mRNA synthesis.

36040 Ion-retardation desalting blood and other animal tissues for separation of soluble metabolites by two-dimensional chromatography. Brooks, G.A.; Bissell, M.J.; Bassham, J.A. (Univ. of California, Berkeley). *Anal. Biochem.;* **83**: No. 2, 580-588(Dec 1977).

Metabolites present in acid extracts of mammalian tissues were desalted by passing the extracts through AG11A8 ion-retardation resin. Quantitative recoveries of alanine, aspartate, glutamate, glutamine, lactate, leucine, and maltose were 95, 100, 92, 85, 96, 90, 97, and 100%, respectively. Effective desalting allows metabolites present in tissue extracts to be separated by two-dimensional paper chromatography.

36041 Sensitive assay of biochemicals by laser-induced molcular fluorescence. Richardson, J.H. (Univ. of California, Livermore). *Anal. Biochem.;* **83**: No. 2, 754-762(Dec 1977).

Parts-per-trillion detection of several vitamins and amino acids has been achieved through the application of laser-induced molecular fluorescence techniques. Compounds which possess native fluorescence were investigated as well as nonfluorescent compounds which could be labeled with fluorescamine. In all cases the use of a pulsed laser as the irradiation source was shown to improve the minimum detectabilities by at least two orders of magnitude over those achieved with conventional light sources.

36042 New type of biological chemiluminescence: the microsomal chemiluminescence of benzo[a]pyrene arises from the diol epoxide product of the 7,8-dihydrodiol. Hamman, J.P.; Gorby, D.R.; Seliger, H.H. (Johns Hopkins Univ., Baltimore). *Biochem. Biophys. Res. Commun.;* **75**: No. 3, 793-798(1977).

The chemiluminescence, CL, accompanying the metabolism of the carcinogen benzo[a]pyrene, BP, by the aryl hydrocarbon hydroxylase system is a new type of low intensity biological chemiluminescence. It is the result of spontaneous oxygenation of a specific reactive metabolic intermediate; not inhibitable by superoxide dismutase or catalase. The reactive metabolite is the strongly mutagenic 7,8-dihydrodiol-9,10-epoxide, produced enzymatically from the 7,8-dihydrodiol precursor. Hydroxylation of benzo[a]pyrene at the 3 position does not lead to chemiluminescent emission; the CL quantum yields of BP and 3-OH-BP are the same. The CL quantum yields of microsomal metabolism of (-) 7,8-diol-BP and the racemic 7,8-diol-BP are identical. The kinetics of CL of the latter show a much faster initial reaction rate, correlating with the greater reactivity of diol epoxide I formed from (+) 7,8-diol-BP. CL may therefore be used to follow the pathways and the rates of production of the mutagenic diol epoxides of BP.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 35772

36043 Properties of dihydroxyacetone phosphate acyltransferase in the harderian gland. Rock, C.O.; Fitzgerald, V.; Snyder, F. (Oak Ridge Associated Universities., TN). *J. Biol. Chem.;* **252**: No. 18, 6363-6366(25 Sep 1977).

We have used a microsomal preparation from the pink portion of the rabbit harderian gland to study the properties of dihydroxyacetone-P acyltransferase. The enzymatic activity in the microsomes is latent and is stimulated approximately 20-fold by the addition of detergent to the assay system. Both deoxycholate and cholate stimulated the enzyme at concentrations considerably below the critical micellar concentration of these detergents. The acyltransferase was not solubilized by treatment with these detergent concentrations. In addition, we have shown that the acyltransferase is sensitive to proteolytic digestion in the presence of deoxycholate concentrations that render the microsomal vesicles permeable to the protease, but is insensitive to the protease treatment in the absence of detergent. Collectively, these data indicate that the active site of dihydroxyacetone-P acyltransferase is exposed to the lumenal surface of the microsomal vesicles. This enzyme is distinct from the glycerol-P acyltransferase in that the dihydroxyacetone-P acyltransferase is sensitive to protease digestion only in the presence of deoxycholate, is not inhibited by sulfhydryl reagents, and is not competitively inhibited by sn-glycerol-3-P.

CYTOLOGY

REFER ALSO TO CITATION(S) 36032

36044 (LA-UR—78-953) **Sorting of a murine granulocytic progenitor cell by use of laser light scattering measurements.** Visser, J.W.M.; Cram, L.S.; Martin, J.C.; Salzman, G.C.; Price, B.J. (Los Alamos Scientific Lab., N.Mex. (USA)). 1977. Contract W-7405-ENG-36. 12p. (CONF-770324—8). Dep. NTIS, PC A02/MF A01.

From 3. international conference on impulse cytophotometry; Vienna, Austria (30 Mar 1977).

Multiangle light-scattering measurements provided a useful basis for analysis and separation of bone marrow cell suspensions. Six to eight major subpopulations of cells could be distinguished by simultaneous measurements of forward and 90° light-scattering, which is more than with any other known cell separation method. The observation that CFU-c were found in only one of these subpopulations confirms the conclusions that CFU-c are a homogeneous population of a single cell type.

36045 Alterations in bone marrow and thymus lymphocytes in virus-inoculated, inbred, preleukemic AKR/J mice: brief communication. Hays, E.F.; Haskett, D.R.; Kaspersky, C.J.; Craddock, C.G.

(Univ. of California, Los Angeles). *J. Natl. Cancer Inst.;* 60: No. 4, 905-909(Apr 1978).

In one study, we compared bone marrow and thymus lymphocytes of 5- to 6-week-old inbred AKR/J mice superinfected with Gross murine leukemia virus (AKR-V) with those of age-matched normal AKR/J mice (AKR-N). The AKR-V mice had marrow lymphopenia, a reduction of thymus weight and cellularity, and an increase in monocyte-granulocyte progenitor cells. The number of totipotent hematopoietic stem cells did not differ in the two groups of mice. In a second study, we evaluated the age-related changes of marrow and thymus lymphocytes in AKR-V and AKR-N mice by comparing 5- and 8-week-old animals (a period covering the transition from adolescence to the adult state). In AKR-V mice, the normal age-related fall in marrow lymphocytes was blunted. This was due to a lesser decrease of T-lymphocytes and null lymphocytes and an increase in immunoglobulin-bearing lymphocytes. The changes in thymus weight and cellularity between 5 and 8 weeks in the AKR-V mice reflected the actual malignant transformation in the thymus. Alterations in marrow and thymus cellularity occurring before the appearance of overt malignant lymphoma were considered in the context of virus-caused alterations of host hematopoiesis in the preleukemic (prelymphoma) state.

36046 Regions of differential cell elongation and mitosis, and root meristem morphology in different tissues of geotropically stimulated maize root apices. Shen-Miller, J.; McNitt, R.E.; Wojciechowski, M. (Argonne National Lab., IL). *Plant Physiol.;* 61: No. 1, 7-12(Jan 1978).

We examined cell length, mitosis, and root meristem "cuticle" in different tissues of geostimulated, red light-exposed pimary roots on corn (Zea Mays, Wisconsin hybrid 64A x 22R). The examination was done at 15-minute intervals for a period of 240 minutes. Differences in cell elongation between the upper and lower sides were most prominent between 1.5 and 2.5 mm from the root meristem; the outer cortex had the greatest elongation growth, and the upper cells showed a significant increase in length compared to the lower. A differential mitosis was also found, with the lower tissue being greater. We infer that the mitotic activity is indicative of cell division, and this division occurs strictly in the first 1.5 mm of the root meristem. The combined effect of differential cell elongation and cell division results in the localization of the geotropic curvature in the 1.5- to 2.5-mm region from the root meristem. Mitosis that occurs primarily in the cortex and stele were asynchronous; the peak of cortical division preceded that of the stele. Both peaks occurred before the peak of geotropism. A densely stained layer separates the cap from the root meristem. This layer is thinner at the apex of the root meristem. The area of the thin region increased with time and peaked at 180 minutes after geostimulation, which was coincidental with the peak of the geotropic response.

36047 Classification of leukemia. Mel, H.C. (Inst. de Pathologie Cellulaire, Paris). *Blood Cells;* 1: 259-262(1975).

Although "Unclassifiable" is also a classification, it is not a useful one for leukemia. A rational (if as yet undiscovered) basis likely exists for a meaningful classification of cells according to parameters critical to leukemia. Beyond refining and quantitating morphological approaches, the need is particularly great for bringing to bear a variety of less conventional biophysical measurements on cells, such as those defining precisely their electrical, hydrodynamic, optical or kinetic properties. There is no assurance that by themselves, or even combined in some pattern these will directly uncover the specific leukemic lesion (if such exist). They will, however, at least provide great economy of effort in the search for such critical parameters, as was provided in the domain of molecular biology by introduction of techniques for defining and identifying molecules according to their sedimentation rate, electrophoretic mobility, optical density, and reaction rate properties.

GENETICS

REFER ALSO TO CITATION(S) 36109

36048 (CONF-780227—5) **Quantitative mammalian cell genetic toxicology: study of the cytotoxicity and mutagenicity of 70 individual environmental agents related to energy technologies and 3 subfractions of a crude synthetic oil in the CHO/HGPRT system.** Hsie, A.W.; O'Neill, J.P.; San Sebastian, J.R. (Oak Ridge National Lab., Tenn. (USA); Tennessee Univ., Oak Ridge (USA). School of Biomedical Sciences). 1978. Contract W-7405-ENG-26. 37p. Dep. NTIS, PC A03/MF A01.

From Symposium on application of short-term bioassays in the fractionation and analysis of complex environmental mixtures; Williamsburg, VA, USA (21 Feb 1978).

Conditions necessary for quantifying mutation-induction to 6-thioguanine resistance, which selects for >98% mutants deficient in the activity of hypoxanthine-guanine phosphoribosyl transferase (HGPRT) in a near-diploid Chinese hamster ovary (CHO) cell line, referred to as CHO/HGPRT system, have been defined. Employing this mutation assay, we have determined the mutagenicity of diversified agents including 11 direct-acting alkylating agents, 16 nitrosamines, 10 heterocyclic nitrogen mustards, 15 metallic compounds, 5 quinolines, 5 aromatic amines, 27 polycyclic hydrocarbons, 13 miscellaneous chemicals, 7 ionizing and non-ionizing physical agents. The direct-acting carcinogen N-methyl-N'-nitro-N-nitrosoguanidine is mutagenic while its noncarcinogenic analogue N-methyl-N'-nitro-N-nitroguanidine is not. Coupled with the rat liver S_9-activation system, procarcinogens such as nitrosopyrrolidine, benzo(a)pyrene, and 2-acetylaminofluorene are mutagenic while their analogues 2,5-dimethylnitrosopyrrolidine, pyrene and fluorene are not. The assay appears to be applicable for monitoring the genetic toxicity of crude organic mixtures in addition to diverse individual chemical and physical agents. The quantitative nature of the assay enables a study of EMS exposure dose: the mutagenic potential of EMS can be described as 310×10^{-6} mutants (cell mg ml^{-1} h).$^{-1}$ It is also feasible to expand the CHO/HGPRT system for quantifying cytotoxicity and mutagenicity to determination of chromosomal aberrations and sister chromatid exchanges in cells treated under identical conditions which allows a simultaneous study of these four distinctive biological effects.

36049 Effect of the Fv-1 locus in vivo: host range pseudotypes of murine sarcoma virus. Otten, J.A. (Oak Ridge National Lab., TN); Myer, F.E.; Tennant, R.W.; Brown, A. *J. Natl. Cancer Inst.;* 60: No. 4, 875-880(Apr 1978).

Fv-1-specific host-range pseudotypes of murine sarcoma virus (MuSV) were developed by rescue from nonproducer cells with N- and B-tropic leukemia viruses. The MuSV(B) and MuSV(N) pseudotype viruses were tested in vitro and were restricted specifically by the Fv-1 gene locus. When the pseudotype viruses were tested in vivo in mice of specific Fv-1 genotypes, tumor induction was completely restricted in nonpermissive animals, including athymic nude mice, whereas tumors grew progressively in permissive animals. All tumors regressed in adult heterozygous mice, but not in adult athymic nude mice.

36050 Alkylation damage and DNA excision repair in mammalian cells. Strauss, B.S.; Karran, P.; Higgins, N.P. (Univ. of Chicago). *J. Toxicol. Environ. Health;* 2: No. 6, 1395-1414(Jul 1977).

Excision repair can be measured by using benzoylated naphthoylated DEAE cellulose (BND cellulose) to filter out DNA formed by replicative synthesis. A rapid batch method that permits analysis of many samples has been developed. Repair can be measured at growing points and in the bulk of the DNA. Using this technology, we have shown that the mutagen methyl nitronitrosoguanidine induces increased repair rates in DNA growing point regions. We have also observed that excision repair capability decreases as chick retinal tissues develop. "Glial-like" cells growing out after trypsinization of the retinas are devoid of measurable repair activity. BND cellulose chromatography can also be used to detect interruptions in DNA. Treatment of cells with methyl methanesulfonate (MMS) leads to interruptions in cellular DNA, in contrast to treatment with acetoxy acetylaminofluorene (AAAF), which is an active repair-inducing agent but which does not induce detectable numbers of breaks in cellular DNA. We conclude that there are at least two mechanisms for excision repair. The first, the MMS type, produces DNA with interruptions and inserts relatively few nucleotides. The second, the AAAF type, does not result in detectable interruptions in DNA and produces relatively long repair patches.

36051 Repair replication and sister chromatid exchanges as indicators of excisable and nonexcisable damage in human (xeroderma pigmentosum) cells. Cleaver, J.E. (Univ. of California, San Francisco). *J. Toxicol. Environ. Health;* 2: No. 6, 1387-1394(Jul 1977).

Alkylating agents cause damage to DNA which can be repaired by excision repair (repair replication) and which induces sister chromatid exchanges (SCEs). During early times after exposure (within 5 hr) normal and xeroderma pigmentosum (XP) cells perform similar amounts of repair replication. At later times (after 20 hr) normal cells have completed repair replication but XP cells continue at a lower rate. This slowly repaired component of alkylation damage appears to be related to the higher frequencies of SCEs induced by alkylating agents in XP cells compared to normal cells. Therefore, whereas repair replication is an indicator of excised damage, SCEs may be indicators of unexcised damage and may show better correlations with the potentially mutagenic and carcinogenic effects of exposure to environmental agents.

36052 Role of mammals in the future of chemical mutagenesis research. Russell, W.L. (Oak Ridge National Lab., TN). *Arch. Toxikol.;* 38: No. 1/2, 141-147(1977).

Radiation genetics has demonstrated that mutagenesis is a complex process affected by many factors. The ABCW hypothesis, that mutation frequency per rad over a wide range of organisms, from microbes to man, is linearly related to DNA content, ignores

the fact that, within the mouse alone, different cell stages exhibit a range of mutation rates greater than that listed for the whole evolutionary tree. Also ignored are the findings that the important effects of dose rate and some other factors in the mousee were not predictable even from Drosophila. A much greater maze of complexities has already been found in chemical mutagenesis. This is illustrated even by the results obtained from testing of a single drug. Thus, it is clear that the attempt to extend the ABCW hypothesis to chemicals will be of little, if any, predictive value. Similarly, such concepts as the REC (roentgen-equivalent-chemical), designed to express the mutagenic risk from a chemical by a single unit quantitatively related to radiation damage, are defeated by the extreme qualitative differences in response. Unifying theories and simple non-mammalian tests that reliably predict the results in mammals cannot be expected to materialize until much more information has been collected on transmitted mutations induced in mammalian germ cells.

36053 Validation of the in vivo somatic mutation method in the mouse as a prescreen for germinal point mutations. Russell, L.B. (Oak Ridge National Lab., TN). *Arch. Toxikol.;* **38**: No. 1/2, 75-85(1977).

The in-vivo somatic mutation method developed by us in an earlier x-ray experiment was tested for its usefulness in chemical mutagenesis work, specifically in the prescreening for germinal point mutations. In order to explore possible parallelisms, the 7 compounds chosen for study, as well as the genetic markers used, were those with which large-scale specific-locus mutation-rate experiments in germcells had been conducted in the past or were in progress. From 1 to 3 dose levels were tested for each compound. On day $10^{3}/_{4}$ after copulation of C57BL females with T males, a single injection of the test compound was administered, and about 2000 offspring altogether were subsequently scored for survival, morphology, and presence of spots of various types. We found 3 types of spots: white near-midline ventral spots (WMVS) which probably result from killing of melanocyte precursor cells; spots resulting from misdifferentiation; and the remainder, which probably result from expression of the recessive by one of several mechanisms (RS). Induction of teratogenic effects, which were stage-specific rather than agent-specific, generally paralleled induction of WMVS's. Induction of RS's did not always parallel induction of WMVS's. Even though the in vivo somatic-mutation method probably detects genetic changes additional to point mutations, the results indicate that it may be a useful prescreen for germinal specific-locus mutations, provided care is taken to distinguish between the 3 types of spots, only one of which (RS) is indicative of expression of the recessive.

36054 Evidence for a four micron replication unit in CHO cells. Taylor, J.H.; Hozier, J.C. (Florida State Univ., Tallahassee). *Chromosoma;* **57**: 341-350(1976).

CHO cells in culture were synchronized by mitotic selection, allowed to reattach to plastic flasks, and reach S phase in the presence of fluorodeoxyuridine at concentrations known to completely block the synthesis of thymidylate. The cells were released from the block with ^{3}H-thymidine for pulses of 4, 8, 12, 24 and 40 min and DNA fiber autoradiographs prepared. An analysis of the spacing between origins of replication indicates that sites are available at intervals of about 4 μm along most of the DNA. Chain growth proceeds at about 1,000 nucleotides per minute and some of the closely situated sites become continuous, labeled segments after 8 to 12 min. However, unlabeled segments are still present between the replicated segments after 40 min. The data may be interpreted as evidence for regularly spaced initiation sites which are available in CHO cells, even though only one in 10 to 15 of these may be utilized for initiation each cycle under normal growth conditions in these cultures.

METABOLISM

REFER ALSO TO CITATION(S) 36032, 36033, 36066, 36101, 36102, 36103

36055 (AECL—5531) Chronic toxicity of the organic reactor coolant OS-84 to an aquatic organism. Guthrie, J.E.; Wiewel, A.M. (Atomic Energy of Canada Ltd., Pinawa, Manitoba. Whiteshell Nuclear Research Establishment). Apr 1977. 20p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The toxicity of irradiated partially hydrogenated polyphenyls to successive generations of Aedes aegypti (Linnaeus) is reported. Suspensions prepared in the laboratory exceeding 0.75 mg/l of the coolant in water significantly affected the survival of the larvae and the percentage of larvae that pupated. No effects on adult emergence, number of eggs laid per female or on the hatching success of these eggs were observed in concentrations ranging from 0.5 to 2 mg/l. Few of the larvae reared in a concentration of 5 mg/l survived beyond the second instar stage and none of them pupated.

36056 (LA—7205-MS) Cobalt retention patterns in mice as influenced by administered dose. Thomas, R.G.; Drake, G.A. (Los Alamos Scientific Lab., N.Mex. (USA)). Mar 1978. Contract W-7405-ENG-36. 6p. Dep. NTIS, PC A02/MF A01.

The effect of various amounts of intravenously injected stable cobalt chloride upon the retention pattern of a tracer dose was studied in mice. Cobalt levels ranged from 2×10^{-4} to 33 mg/kg body weight. First-order kinetic analysis indicated that, as the dose of cobalt was increased, the long-term retention component had a slower rate of loss from the body and represented a smaller fraction of that injected. This "carrier effect" represents a satisfactory explanation of the retention parameters observed when the same total cobalt dose was administered to mice, rats, monkeys, and dogs. In that study, the cobalt dosage concentration ranged over a factor of 1300 between rodents and large animals. The results presented here emphasize the effect of administered quantity upon the metabolic pattern of a substance.

36057 Phytoplankton extracellular release and its relation to the seasonal cycle of dissolved organic carbon in a eutrophic lake. Storch, T.A. (State University Coll., Fredonia, NY); Saunders, G.W. *Limnol. Oceanogr.;* **23**: No. 1, 112-119(Jan 1978).

The concentration of total dissolved organic carbon (TDOC), the daily rates of release of extracellular dissolved organic carbon (DOC) by viable phytoplankton, and the daily rates of assimilation of the phytoplankton extracellular DOC by bacteria were investigated simultaneously from April through October in Frains Lake, Michigan. The concentration of TDOC varied aperiodically. The release of DOC by phytoplankton and its utilization by bacteria fluctuated markedly, but these processes did not play a significant role in causing the seasonal variations of TDOC. Increases in the concentration of TDOC greatly exceeded the amounts accumulated from release by the phytoplankton, even when maximum rates of phytoplankton DOC release were calculated by assuming release exclusively from a large intracellular pool not at isotopic equilibrium. In addition, bacterial utilization of the phytoplankton DOC alone could not account for decreases in TDOC concentration. Therefore, there must be other major sources of dissolved organic matter than that provided by the mechanism of extracellular release by phytoplankton. The littoral flora and the decomposition of dead particulate organic materials are the most likely sources of fluctuations of TDOC in Frains Lake.

36058 Kinetics of algal transient phosphate uptake and the cell quota concept. Brown, E.J.; Harris, R.F. (Univ. of Wisconsin, Madison). *Limnol. Oceanogr.;* **23**: No. 1, 35-40(Jan 1978).

Dissolved inorganic orthophosphate (P_1) uptake rates (v) were determined as a function of total cell phosphorus content (Q) in P_1 perturbed axenic batch cultures of Selenastrum capricornutum and Nostoc sp. The results showed an inverse relationship between v and Q for both organisms. These findings are used to relate the cell quota concept of nutrient limited, steady state microbial growth kinetics to nutrient uptake kinetics observed in perturbed batch cultures.

36059 Aerobic glycolysis in bone: lactate production and gradients in calvaria. Neuman, W.F.; Neuman, M.W.; Brommage, R. (Univ. of Rochester Medical Center, NY). *Am. J. Physiol.;* **234**: No. 1, C41-C50(Jan 1978).

The experiments utilized specially designed Ussing chambers to measure lactate production and release by intact cranial bones in vitro. The net outflow of lactate was measured from both the inner and outer surfaces of cranial bones (18-day-old embryonic chicks and 2- to 3-day old rat pups were the donor sources). The net outward fluxes were surprisingly large: 0.5-1.0 μmol/cm^2.h; so large that the skeleton must be considered an important source of lactate in the overall carbohydrate economy of the intact animal. Lactate production was inhibited by lowered pH, external lactate, and disruption of the K^+ gradient between bone and the external medium. Lactate production was increased by pretreatment with parathyroid hormone or an inhibitor of phosphorylation, carbonyl cyanide 3-chlorophenylhydrazone (CCCP). A good, positive correlation was observed between serum calcium in the rat pup and lactate production in vitro. Measurements of the lactate levels in the bone fluid showed that a real gradient exists, in concentrations 5 mM or more greater than those of the external medium.

36060 Aerobic glycolysis in bone: lactic acid production by rat calvaria cells in culture. Felix, R.; Neuman, W.F.; Fleisch, H. (Univ., Bern). *Am. J. Physiol.;* **234**: No. 1, C51-C55(Aug 1976).

Considerable data have been accumulated on aerobic glycolysis of intact bone preparations. To test whether aerobic glycolysis is a feature of the bone cells themselves or of the localized conditions within an intact bone, cells isolated from rat calvaria were cultured and the effect of several factors on lactate production was determined. These cells drastically decreased lactate production when the pH in the culture medium was lowered, changing from 100 to 20% for a pH shift from 7.4 to 6.75. L-lactate inhibited its own formation by 40% at 20 mM. Parathyroid hormone (PTH) (820 U/mg) at a

concentration ranging from 0.2 to 5.0 U/ml stimulated slightly the lactate production in a log-linear response, the ratio treated over control changing from 1.1 to 1.3. The maximal stimulation is observed at pH 7.0. Isolated cells respond qualitatively the same as did intact calvaria. Quantitatively, there were significant differences: notably, a smaller response to parathyroid hormone and a higher sensitivity to lowered pH.

36061 Transcellular transport of calcium. Terepka, A.R.; Coleman, J.R.; Armbrecht, H.J.; Gunter, T.E. (Univ. of Rochester, NY). *Symp. Soc. Exp. Biol.;* No. 30, 117-140(1976).

Studies of two calcium transporting epithelia, embryonic chick chorioallantoic membrane and the small intestine of rat and chick, have strongly suggested that the transfer of calcium across a cell involves processes distinctly different from intracellular calcium ion regulation. In the proposed model, transcellular calcium transport is considered as a specialized process developed only by certain cells in those tissues charged with bulk transfer of calcium. The overall effect of the endocytotic mechanism is bulk calcium movement across a cell, protection of mitochondria from exposure to high concentrations of calcium, and the avoidance of wide and potentially toxic fluctuations in cytosol ionic calcium levels. (MFB)

TRACER TECHNIQUES

36062 Kinetics of phosphate uptake by aquatic microorganisms: deviations from a simple Michaelis—Menten equation. Brown, E.J. (Univ. of Wisconsin, Madison); Harris, R.F.; Koonce, J.F. *Limnol. Oceanogr.;* **23**: No. 1, 26-34(Jan 1978).

The uptake kinetics of dissolved inorganic phosphate ($^{31}P_i$) by lake water microorganisms and a green alga (Selenastrum capricornutum) were determined as a function of uptake rates of radiophosphate ($^{32}P_i$) at added $^{31}P_i$ levels $\geqq 0$. The data did not follow a simple Michaelis-Menten equation.

MEDICINE

REFER ALSO TO CITATION(S) 36032, 36087

36063 (FMI—44, pp 33-40) **Nuclear medicine and imaging studies.** (33-40). 1977.

In Annual report, 1977.

The development of radiopharmaceuticals labelled with cyclotron produced radionuclides is discussed. New products include ^{51}Mn for positron imaging, and $N_2{}^{15}O$ and $H_2{}^{15}O$ for cerebral tomographic studies. Improved tomographic imaging and quantitative uptake studies using a double-camera positron system with computer data analysis are reported. A whole-body counting system was constructed for positron counting. Five solid-state detector systems were evaluated for imaging radionuclide tissue distribution in patients and phantoms were developed for quality assurance in radioisotope scanning. Results are reported of a pilot study of a magnification technique for x-ray mammography in which direct radiographic magnification with a microfocus x-ray tube was compared with conventional contact mammography. The magnification technique substantially reduced the radiation dose to the skin of the patient and did not substantially alter the diagnostic accuracy in 100 patients studied.

36064 (LA—7107-MS) **Development of a proton radiographic system for diagnosis and localization of soft-tissue abnormalities. Final report.** Hanson, K.M. (Los Alamos Scientific Lab., N.Mex. (USA)). Feb 1978. Contract W-7405-ENG-36. 9p. Dep. NTIS, PC A02/MF A01.

The results of a project to develop a proton computed tomographic (CT) scanning system are reviewed. A high-quality proton CT reconstruction is presented which verifies the substantial dose advantage protons possess over x rays in obtaining CT reconstructions of equivalent density resolution. Furthermore, the unusual aspects of CT reconstruction noise are discussed. Modifications to the Moliere theory of multiple Coulomb scattering are described.

36065 (LA—7155-MS) **Electrothermal technique for the alteration of corneal curvature.** Doss, J.D.; Hutson, R.L.; Albillar, J.I. (Los Alamos Scientific Lab., N.Mex. (USA)). Feb 1978. Contract W-7405-ENG-36. 9p. Dep. NTIS, PC A02/MF A01.

Extreme cases of refractive error, such as those caused by keratoconus, are often not correctable by the addition of external refraction. In such cases, corneal transplant is the usual remedy. Alternatives have recently included modification of the corneal shape by thermal techniques which exploit the dramatic shrinkage of corneal collagen at temperatures of 55 to 63°C. The use of conventional thermal techniques has been limited by damage to the epithelium and Bowman's membrane, and by the observation that the change in corneal shape is often temporary. Each of these problems appears to be related to the thermal dose profile that is generated by the conductive heating method; temperature is relatively high in the epithelium, but is below the critical shrinkage temperature in the deeper stromal collagen. A wide variability in treatment results has also been reported; this may be due to unintentional variation in technique, especially in timing the treatment. An alternative heating technique will be discussed that has a more desirable thermal dose distribution. In addition, the technique allows precise electronic control of treatment duration, and other parameters that affect thermal dose to the cornea.

36066 Liposome encapsulation of chelating agents. Rahman, Y.E. (to Energy Research and Development Administration). US Patent 3,932,657. 13 Jan 1976. Filed date 12 Nov 1973. 10p.

PAT-APPL-415,077.

A method for transferring a chelating agent across a cellular membrane by encapsulating the charged chelating agent within liposomes and carrying the liposome-encapsulated chelating agent to the cellular membrane where the liposomes containing the chelating agent will be taken up by the cells, thereby transferring the chelating agent across the cellular membrane. A chelating agent can be introduced into the interior of a cell of a living organism wherein the liposomes will be decomposed, releasing the chelating agent to the interior of the cell. The released chelating agent will complex intracellularly deposited toxic heavy metals, permitting the more soluble metal complex to transfer across the cellular membrane from the cell and subsequently be removed from the living organism.

36067 Inhibition of time-dependent enhancement of amino acid transport by leukemic leukocytes: a possible index of the sensitivity of cells to drugs. Frengley, P.A.; Peck, W.A.; Lichtman, M.A. (Univ. of Rochester School of Medicine, NY). *Blood Cells;* **1**: 139-146(1975).

Leukemic leukocytes increase their rates of alpha aminoisobutyric acid (AIB) accumulation when incubated for prolonged periods in amino acid deficient media. The time-dependent increase was prevented by concurrent exposure of cells to cycloheximide or actinomycin D in vitro. In addition, the increase in AIB uptake was not present in leukemic blasts studied in vitro when the cells were obtained from subjects with acute myeloblastic leukemia who had received antileukemic therapy. Cortisol added to cell suspensions in vitro inhibited the development of time-dependent increases in AIB uptake in lymphoid cells, but accentuated the process slightly in myeloblasts. Cortisol administered to a subject with CLL by infusion reduced the time-dependent increase in AIB uptake by CLL cells subsequently studied in vitro. These data indicate that the time-dependent increase in AIB uptake may be a means of testing the sensitivity of leukemic cells to drugs.

TRACER TECHNIQUES

REFER ALSO TO CITATION(S) 35897, 35899, 35900, 35902

36068 (ORNL/TM—5875/V3) **ORIS: the Oak Ridge Imaging System program listings.** Bell, P.R.; Dougherty, J.M. (Oak Ridge National Lab., Tenn. (USA)). Apr 1978. Contract W-7405-ENG-26. 417p. Dep. NTIS, PC A18/MF A01.

The Oak Ridge Imaging System (ORIS) is a general purpose access, storage, processing and display system for nuclear medicine imaging with rectilinear scanner and gamma camera. This volume contains listings of the PDP-8/E version of ORIS Version 2. The system is designed to run under the Digital Equipment Corporation's OS/8 monitor in 16K or more words of core. System and image file mass storage is on RK8E disk; longer-time image file storage is provided on DECtape. Another version of this program exists for use with the RF08 disk, and a more limited version is for DECtape only. This latter version is intended for non-medical imaging.

36069 Tc-99m sulfur colloid radiopharmaceuticals. Garrett, M.D. (to Medi-Physics, Inc.). US Patent 4,066,742. 3 Jan 1978. Filed date 14 Feb 1977. 6p.

A /sup 99m/Tc stannous sulfur colloid radiopharmaceutical having simplicity of formulation, improved stability and desirable small particle size as well as a method of preparation therefor are described. Also provided is a reagent suitable for the preparation of such radiopharmaceutical by the addition thereto of /sup 99m/Tc pertechnetate.

36070 Detection of prostatic cancer by solid-phase radioimmunoassay of serum prostatic acid phosphatase. Foti, A.; Cooper, J.F.; Herschman, H.; Malvaez, R.R. *New Engl. J. Med.;* **297**: No. 25, 1357-1361(22 Dec 1977).

We compared our radioimmunoassay with the standard enzyme assay for prostatic acid phosphatase in the diagnosis of prostatic cancer. Serum samples from 50 controls, 113 patients with prostatic cancer, 36 with benign prostatic hyperplasia, 83 with other cancers, 20 with gastrointestinal disorders and 28 with total prostatectomies were randomized and studied by radioimmunoassay and enzyme assay. When the upper limit was set at 8.0 ng per milliliter (mean + 4 S.D.) the radioimmunoassay diagnosed prostatic cancer in 33, 79, 71 and 92 percent of the patients with Stage I, II, III and IV disease. In contrast, the enzyme assay detected elevations of

enzyme in the serum of 12, 15, 29, and 60 percent respectively. No false-positive results were detected by either assay in normal controls but the radioimmunoassay test was positive in two patients with benign prostatic hyperplasia, in one patient after total prostatectomy, in nine with other cancers and in one of the group with gastrointestinal disorders. In contrast to the enzyme assay, the radioimmunoassay distinguished over half the cases of intracapsular prostatic cancer.

36071 Tumor location with 1-aminocyclopentane [^{11}C] carboxylic acid: preliminary clinical trials with single-photon detection. Huebner, K.F.; Andrews, G.A.; Washburn, L.; Wieland, B.W.; Gibbs, W.D.; Hayes, R.L.; Butler, T.A.; Winebrenner, J.D. (Oak Ridge Associated Universities, Inc., TN). *J. Nucl. Med.;* **18**: No. 12, 1215-1221(Dec 1977).

High specific activity [^{11}C] carboxyl-labeled I-aminocyclopentane-carboxylic acid ([^{11}C] ACPC) was tested as a tumor-scanning agent in thirty-eight patients. This artificial amino acid clears the blood to a level of less than 12% within 45 min; thus, imaging is possible within the useful life of C-11. [^{11}C] ACPC can be produced in amounts adequate for clinical scanning. Doses between 12 and 45 mCi were given by i.v. injection, and scans obtained only in the single-photon mode gave clinical information on the sites of tumors. There was no evidence of any toxic effects from [^{11}C] ACPC, and the radiation doses as extrapolated from animal data are approximately 0.01 rad per mCi for the whole body and less than 0.06 rad per mCi for the pancreas. In all but five of the 38 patients [^{11}C] ACPC scans were compared with those obtained with Ga-67 citrate. There were 19 positive [^{11}C] ACPC scans and 24 positive Ga-67 scans. The results indicate that [^{11}C] ACPC is likely to be of diagnostic value for cancer patients if used in conjunction with positron tomography instrumentation.

MICROBIOLOGY

REFER ALSO TO CITATION(S) 36104

36072 Transfection in pneumococcus: single-strand intermediates in the formation of infective centers. Porter, R.D.; Guild, W.R. (Duke Univ., Durham, NC). *J. Virol.;* **25**: No. 1, 60-72(Jan 1978).

Transfection has been found and characterized in pneumococcus. For replicating ω3 phage DNA extracted from infected cells, transfection was relatively efficient and rose linearly with DNA concentration and quadratically with time, according to $T(T - 3.5)$ min^2. For mature DNA extracted from phage particles, transfection was hardly detectable below 1 μg/ml but increased about as the cube of the DNA concentration up to 100 μg/ml, and was still rising at concentrations over 200 μg/ml. The kinetics suggest a dependence on a mixed cubic function of the time of exposure of cells to mature DNA. Cell and phage DNAs competed with each other for transformation and transfection. Transfection was reduced much more strongly than transformation in cells that were deficient in the membrane-bound endonuclease required for conversion of donor duplex DNA to intracellular single strands; these data agree with the kinetic data in implying that independent entry of segments of two strands is necessary for transfection by replicating ω3 phage DNA and entry of at least three strands is necessary for transfection by mature DNA.

36073 Physiological response of Neurospora conidia to freezing in the dehydrated, hydrated, or germinated state. Leef, J.L.; Mazur, P. (Univ. of Tennessee, Oak Ridge). *Appl. Environ. Microbiol.;* **35**: No. 1, 72-83(Jan 1978).

The study concerned the response of freezing of Neurospora crassa conidia in four different states: air-dry, hydrated in water, hydrated in Vogel medium lacking only sucrose, or hydrated in complete Vogel medium. All hydrated conidia were incubated before freezing. Rapidly cooled conidia survived freezing to a much higher extent when the warming rate was rapid than when it was slow; slowly cooled conidia showed little or no dependence on the warming rate. This sensitivity to rapid cooling and slow warming was attributed to the effects of intracellular ice. The sensitivity to freezing could be reversed by dehydrating the conidia in vacuo before freezing; thus, it was concluded that the presence or absence of water is the determining factor in the initial sensitivity due to freezing. In water, the sensitivity remained constant from 2 min to 15 days after hydration. Although conidia hydrated in growth medium lacking sucrose remained metabolically inactive, their sensitivity to rapid freezing decreased as a function of time in the medium before freezing. The reason for this decreased sensitivity is not understood. Conidia hydrated in complete growth medium (i.e., containing sucrose) became metabolically active and, after the initial sensitivity associated with hydration, became increasingly more sensitive to freezing as a function of their time in the medium. Drying itself was deleterious to metabolically active conidia, and those that survived dehydration did not exhibit a large absolute increase in resistance to subsequent freezing. The increase in sensitivity to freezing and to drying seems associated with the presence of metabolic activity; however, the precise cause of the sensitization remains obscure.

36074 Chaetomium cellulolyticum, growth behavior on cellulose and protein production. Chahal, D.S. (Univ. of Waterloo, Ont.); Wang, D.I.C. *Mycologia;* **70**: No. 1, 160-170(1978).

The growth behavior of Chaetomium cellulolyticum in cellulose medium indicated that long fibers of cellulose (Solka-Floc S.W. 40) are broken into shorter ones during the early phases of fermentation followed by longitudinal splitting of short fibers into fibrils and ultimately almost complete utilization of the substrate. Chaetomium cellulolyticum was found to be a fast-growing organism on 1 percent cellulose with a protein synthesis rate of 0.09 h^{-1}. The rate of protein synthesis increased more than threefold (0.3 h^{-1}) when 1 percent more substrate was added immediately after the complete conversion of the first batch of substrate. The growth behavior of C. cellulolyticum on cellulose indicated that it might be the most suitable organism for cyclic-batch or continuous fermentation of cellulose for microbial protein production. NaOH utilization, to keep the level of pH at 5.0 during fermentation, correlated positively with the synthesis of protein. The rate of NaOH utilization during fermentation could be used as an indication of growth of or protein synthesis by an organism when other methods cannot be used immediately.

36075 Modeling and simulation of oxygen transfer in airlift fermentors. Ho, C.S.; Erickson, L.E.; Fan, L.T. (Kansas State Univ., Manhatten). *Biotechnol. Bioeng.;* **19**: No. 10, 1503-1522(Oct 1977).

A mathematical model for simulation of oxygen transfer in airlift fermentors is presented. The airlift fermentor is represented by a number of interconnected compartments, each of which is assumed to be well mixed. In the annular region, the model includes both upflow and downflow for the gas phase. The model contains several adjustable parameters through which important hydrodynamic effects affecting oxygen transfer are incorporated. The effect of hydrostatic pressure is also included in the model. The model is simple enough to be used in design studies and it can be easily adapted to other airlift system configurations. The simulation results show good qualitative agreement with available experimental results.

36076 Evaluation of aeration capacity from cultivation data files: application to large-scale fermentations. Votruba, J.; Sobotka, M.; Prokop, A. (Inst. of Microbiology, Prague). *Biotechnol. Bioeng.;* **19**: No. 10, 1553-1556(Oct 1977).

A method is given for using data from the measurement of oxygen concentration either dissolved in the cultivation broth or in the outgoing gas phase to evaluate the aeration capacity of large-scale fermentations. The aeration capacity can be determined either simultaneously with other biological-kinetic parameters or as a separate physicokinetic parameter on the basis of a set of dynamic mass balances. (JSR)

PATHOLOGY

REFER ALSO TO CITATION(S) 36031, 36067, 36119

36077 (CONF-7510172—P2, pp 1219-1229) **Investigations on the thermal behavior of plants affected by virus and fungus diseases (Tobacco Mosaic Virus in Nicotiana tabacum L. cv. Xanthi nc., and Uromyces appendiculatus (PERS.) link in Phaseolus vulgaris L.).** De Carolis, C. (Univ., Milan); Conti, G.G.; Lechi, G.M. 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The behavior in the thermal infrared of different plants infected with viruses and fungi is now under investigation in our laboratory. These studies are carried out in 2—5.6 and 9-II micron bands, from aircraft at the ground level. In this last case, the distance ranges from 20 m to 5 cm. Leaves radiance variations are detected by remote sensing techniques and could contribute to the knowledge of the energetic behavior of diseased plants. It seems to be the first time that this approach is employed in the field of plant pathology. In fact, the possibility to correlate the thermal behavior with the metabolism and physiology of infected plant tissues should be a very good tool for the investigation of host-pathogen interactions. Following the 1974 researches, in this paper the results of radiometric measurements (2/5.6 micron band) are presented, concerning Nicotiana tabacum cv. Xanthi nc. plants experimentally infected with Tobacco Mosaic Virus (TMV) and bean plants inoculated with Uromyces appendiculatus. The investigation was carried out just from the inoculation to the 6th and 14th day, respectively.

36078 Uremic hyperstannum: elevated tissue tin levels associated with uremia. Nunnelley, L.L.; Smythe, W.R.; Alfrey, A.C.; Ibels, L.S. (Univ. of Colorado, Boulder). *J. Lab. Clin. Med.;* **91**: No. 1, 72-75(Jan 1978).

Previous work has shown that the concentration of the essential trace element tin is elevated in several tissues of dialyzed uremic patients. Analysis of 80 postmortem liver samples from controls and nondialyzed uremic and dialyzed uremic patients now shows that nondialyzed uremic patients also have abnormally high tin concentrations, averaging about three times that of controls. It is concluded that these elevated tin levels are associated with uremia rather than with dialysis. Abnormally high tin levels were also found in the kidneys of uremic patients at autopsy. This may have special importance, since tin has been shown to be a powerful inducer of heme oxygenase activity in rat kidney. The urinary excretion of tin by nondialyzed uremic patients was measured and found to be normal.

36079 Photosensitizing effects of 8-methoxypsoralen on the skin of hairless mice. II. Strain and spectral differences for tumorigenesis. Grube, D.D.; Ley, R.D.; Fry, R.J.M. (Argonne National Lab., IL). *Photochem. Photobiol.;* **25**: 269-276(1977).

The photosensitizing effects of 8-methoxypsoralen on the skin of two strains of hairless mice were studied using fractionated exposure to UV. Spectral dependent differences for tumorigenesis were studied by comparing the tumor responses to three different spectra; the exposure levels for each spectrum were adjusted in proportion to their relative efficiencies for tissue damage and cytokinetic responses. There were no strain differences in the spectral dependent induction of cutaneous damage or estimates of the photomediated interstrand cross-linking of epidermal DNA by 8-methoxypsoralen. Squamous cell carcinomas were induced in the photosensitized skin of both strains of mice after fractionated exposures to emissions at principally 365 nm. Exposures to a broader spectrum of light resulted in the earlier appearance of tumors in the photosensitized skin of the SKH:hairless-1 mice, but produced few or no tumors in the HRS/J/Anl strain. In a second series of experiments, mice were exposed to a fluorescent sun lamp prior to each combined treatment of psoralen and exposure at 365 nm to determine the influence of shorter wavelengths of UV on the tumor response. These treatments resulted in an enhanced expression of tumors in the SKH:hairless-1 mice as compared to the HRS/J/Anl strain. Under the conditions of the experiments, the marked strain and spectral dependent differences for tumorigenesis demonstrated that although treatments that induced psoralen photoadducts also induce tumors, there was no apparent quantitative correlation between the occurrence of DNA cross-links and the incidence of tumors. The results also suggested, first, an interaction between UV (280 to 400 nm) induced photoproducts and psoralen photoadducts and secondly, a strain difference in the oncogenic effects of this interaction.

PHYSIOLOGICAL SYSTEMS

REFER ALSO TO CITATION(S) 36032, 36033

PUBLIC HEALTH

REFER ALSO TO CITATION(S) 36104

AGRICULTURE AND FOOD TECHNOLOGY

REFER ALSO TO CITATION(S) 34743, 35964, 35968, 35970, 35972, 35975, 35984, 36146

36080 (CONF-7510172—P1, pp 17-37) **Large Area Crop Inventory Experiment (LACIE): an assessment after one year of operation.** MacDonald, R.B.; Hall, F.G.; Erb, R.B. (Lyndon B. Johnson Space Center, Houston, TX). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

A Large Area Crop Inventory Experiment (LACIE) has been undertaken jointly by the U.S. Department of Agriculture (USDA), the National Oceanic and Atmospheric Administration (NOAA) of the Department of Commerce and the National Aeronautics and Space Administration (NASA) to prove out an economically important application of remote sensing from space. The first phase of the Experiment, which focused upon determinations of wheat area in the U.S. Great Plains and upon the development and testing of yield models, is now nearing completion. The system implemented to handle and analyze the Landsat and meteorological data has generally worked well and met operational goals. A very preliminary assessment of results to date indicates that the accuracy goals of the experiment can be met.

36081 (CONF-7510172—P2, pp 1427-1436) **Evaluation of thermography as an aid to scheduling the harvest of sugarbeet storage piles to minimize spoilage losses.** Moore, D.G.; Bichsel, S.; Best, R. (South Dakota State Univ., Brookings). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

Heat generated by in-pile storage rot in sugarbeet piles produces a temperature anomaly associated with the spoilage areas. Since a large portion of the heat is transferred vertically producing a "chimney" and creating a surface temperature anomaly, an investigation to evaluate the use of airborne thermography for locating spoilage areas was jointly pursued by the American Crystal Sugar Company and the Remote Sensing Institute, South Dakota State University. Aerial thermal-infrared scanner data were acquired during predawn hours over sites in Minnesota and North Dakota in both January and February. Field evaluations of interpretations from the thermography revealed that a greater number of spoilage areas could be detected using thermography than were detected using traditional methods of walking the piles and/or monitoring temperatures by contact temperature sensors buried within the piles. When spoilage is detected in early season, the piles are sectioned for processing according to the distribution of spoilage. In the late processing season, the piles are scheduled according to those with the greatest overall spoilage. An estimate of savings associated with early detection of in-pile storage rot using thermography for the beet sugar industry in the Red River Valley could approximate $1.75 million per year. The American Crystal Sugar Company is presently planning to use the thermography for scheduling pile processing as an operational procedure for the next harvest season.

36082 Rapid release of protease inhibitors from soybeans. Immunochemical quantitation and parallels with lectins. Hwang, D.L. (Univ. of Tennessee, Oak Ridge); Yang, W.K.; Foard, D.E.; Lin, K.T.D. *Plant Physiol.;* **61**: No. 1, 30-34(Jan 1978).

Specific antisera were prepared against the Bowman-Birk trypsin inhibitor and four other trypsin inhibitors of low molecular weight isolated from soybeans. These were used to detect the presence and amount of the inhibitors in: (a) seeds and protein extracts of soybean meal; (b) seedlings; and (c) the water surrounding the seeds and roots of seedlings. Lectin activities in seeds, seedlings, and water were also determined at the same time as the protease inhibitor activities. By competitive inhibition of immunoprecipitation, the combined five low molecular weight protease inhibitors were found to constitute the following percentages of proteins (w/w); 6.3% in defatted soybean meal; 8.1% of the protein extracted from the meal by a buffer of pH 8.6; 8.3, 14.7, 15.2, 16.1, 17.2, and 18.9% of the protein in a lyophilisate of water in which seeds were incubated for 4, 8, 12, 16, 20, and 24 hours, respectively; 8.2% in a lyophilisate of water in which roots of seedlings grew for 20 days; 1.5% in cotyledons; and less than 0.1% in epicotyls, hypocotyls, and roots of 12-day-old seedlings. Hemagglutination activities, expressed as the lowest amount of protein required to give a positive agglutination of 0.2 ml of 2% rabbit red blood cells, were as follows: purified soybean lectin, 0.08 μg; lyophilisate of water in which seeds were incubated for 4, 8, 12, 16, 20, and 24 hours, 10, 2.5, 5, 5, and 2.5 μg, respectively; lyophilisate of water in which roots grew for 20 days, 5 μg; 12-day-old cotyledons, roots, epicotyls, and hypocotyls, 12.5, 100, >1000, and >500 μg, respectively. The results indicate that a large amount of protease inhibitors as well as lectins are released from seeds during the first 8 hours of imbibition. Neither lima bean trypsin inhibitor (mol wt, 10,000) nor Kunitz soybean trypsin inhibitor (mol wt, 21,500) showed competitive inhibition in tests with antisera against low molecular weight soybean protease inhibitors.

36083 Water potential in excised leaf tissue. Comparison of a commercial dew point hygrometer and a thermocouple psychrometer on soybean, wheat, and barley. Nelsen, C.E.; Safir, G.R.; Hanson, A.D. (Michigan State Univ., East Lansing). *Plant Physiol.;* **61**: No. 1, 131-133(Jan 1978).

Leaf water potential (Psi/sub leaf/) determinations were made on excised leaf samples using a commercial dew point hygrometer (Wescor Inc., Logan, Utah) and a thermocouple psychrometer operated in the isopiestic mode. With soybean leaves (Glycine max L.), there was good agreement between instruments; equilibration times were 2 to 3 hours. With cereals (Triticum aestivum L. and Hordeum vulgare L.), agreement between instruments was poor for moderately wilted leaves when 7-mm-diameter punches were used in the hygrometer and 20-mm slices were used in the psychrometer, because the Psi/sub leaf/ values from the dew point hygrometer were too high. Agreement was improved by replacing the 7-mm punch samples in the hygrometer by 13-mm slices, which had a lower cut edge to volume ratio. Equilibration times for cereals were normally 6 to 8 hours. Spuriously high Psi/sub leaf/ values obtained with 7-mm leaf punches may be associated with the ion release and reabsorption that occur upon tissue excision; such errors evidently depend both on the species and on tissue water status.

BIOMEDICAL SCIENCES, APPLIED STUDIES

RADIATION EFFECTS ON CELLS

EXTERNAL SOURCE

36084 (BNL—24009) **Excision repair in mammalian cells.** Ahmed, F.E.; Setlow, R.B. (Brookhaven National Lab., Upton, N.Y. (USA)). 1978. Contract EY-76-C-02-0016. 8p. (CONF-780226—4). Dep. NTIS, PC A02/MF A01.

From Symposium on DNA repair mechanisms; Keystone, CO, USA (19 Feb 1978).

Excision repair after combined treatments of uv and N-acetoxy-2-acetylaminofluorene (AAAF) was studied by three different techniques in cells proficient in uv excision repair and in cells deficient in uv repair. Two patterns of repair were observed: in repair proficient cells total repair was additive, and in repair deficient cells total repair was much less than additive--usually less than observed for separate treatments--and AAAF inhibited dimer excision. We conclude that in the 1st class of cells pathways for repair of uv and AAAF lesions are not identical, and in the 2nd class the residual excision enzymes are different from those in repair proficient cells.

RADIATION EFFECTS ON MICROORGANISMS

BASIC STUDIES

36085 Isolation and characterization of mutants of the plasmid pKM101 deficient in their ability to enhance mutagenesis and repair. Walker, G.C. (Univ. of California, Berkeley). *J. Bacteriol.;* **133**: No. 3, 1203-1211(Mar 1978).

A screening procedure was developed for identifying mutants of the plasmid pKM101 no longer capable of enhancing mutagenesis. The test was based on the large pKM101-mediated increase in the number of Gal^4 papillae observed on colonies of Salmonella typhimurium gal mutants plated on tetrazolium galactose plates in the presence of a mutagen. The pKM101 mutant plasmids transferred normally, were stably maintained in cells, caused normal levels of ampicillin resistance, and still imparted sensitivity to phage Ike to their hosts. However, the pKM101 mutants had lost the ability to enhance the reversion of both point and frameshift mutations, protect the cells against killing by uv irradiation, increase the spontaneous reversion rates of point mutations, enhance plasmid-mediated reactivation of uv-irradiated phage P22, enhance Weigle reactivation. One pKM101 mutant with different properties from the others was identified by its increased spontaneous mutator effect. It is suggested that pKM101 amplifies the activity of the inducible error-prone repair systems in bacteria and that this is the function of pKM101 in the Ames Salmonella tester strains used for detection of carcinogens as mutagens.

RADIATION EFFECTS ON ANIMALS

MAN

REFER ALSO TO CITATION(S) 36029, 36032, 36063, 36064

36086 (BNWL—2100(Pt.5), pp 51-61) **Operational safety.** Jun 1977.

In Pacific Northwest Laboratory annual report for 1976 to the ERDA Assistant Administrator for Environment and Safety. Part 5. Control technology, overview, safety, and policy analysis.

The PNL Safety, Standards and Compliance Program contributed to the development and issuance of safety policies, standards, and criteria; for projects in the nuclear and nonnuclear areas. During 1976 the major emphasis was on developing criteria, instruments and methods to assure that radiation exposure to occupational personnel and to people in the environs of nuclear-related facilities is maintained at the lowest level technically and economically practicable. Progress in 1976 is reported on the preparation of guidelines for radiation exposure; Pu dosimetry studies; the preparation of an environmental monitoring handbook; and emergency instrumentation preparedness.

36087 (ORNL/TM—5933) **Evaluation of the distribution of absorbed dose in child phantoms exposed to diagnostic medical x rays.** Chen, W.L.; Poston, J.W.; Warner, G.G. (Oak Ridge National Lab., Tenn. (USA)). Apr 1978. Contract W-7405-ENG-26. 228p. Dep. NTIS, PC A11/MF A01.

Thesis. Submitted by W.L. Chen to Georgia Institute of Technology, Atlanta.

The purpose of this study was to determine, by theoretical calculation and experimental measurement, the absorbed dose distributions in two heterogeneous phantoms representing one-year- and five-year-old children from typical radiographic examinations for those ages. Theoretical work included the modification of an existing internal dose code which uses Monte Carlo methods to determine doses within the Snyder-Fisher mathematical phantom. A Ge(Li) detector and a pinhole collimator were used to measure x-ray spectra which served as input to the modified Monte Carlo codes which were used to calculate organ doses in children. The calculated and measured tissue-air values were compared for a number of organs. For most organs, the results of the calculated absorbed doses agreed with the measured absorbed doses within twice the coefficient of variation of the calculated value. The absorbed dose to specific organs for several selected radiological examinations are given for one-year-old, five-year-old, and adult phantoms.

36088 (RHO-CD—222) **Rockwell Hanford Operations' 1978 radiological improvement program.** Cunningham, D.S. (Atomics International Div., Richland, Wash. (USA). Rockwell Hanford Operations). 30 Dec 1977. Contract EY-76-C-06-1030. 8p. Dep. NTIS, PC A02/MF A01.

This document describes the radiological improvement program (RIP) to be undertaken by Rockwell Hanford Operations during calendar year 1978. Actions taken in each facility to reduce exposure and to implement the Company's policy to conduct operations in a manner that assures radiation exposures to employees are maintained at the lowest levels reasonably achievable.

36089 Murine T-cell preparations: radiosensitivity of helper activity. Lawrence, D.A.; Eastman, A.; Weigle, W.O. (Medical Coll. of Union Univ. Albany). *Cell. Immunol.;* **36**: No. 1, 97-114(1 Mar 1978).

Sheep red blood cell (SRBC)-primed T-cells obtained by two different methods had differential helper activity kinetics and sensitivities to radiation. The helper activities of primed T-cells (pT) isolated from SRBC-immunized mice by glass wool-nylon fiber column purification and SRBC-activated T-cells (ATC) prepared by injection of thymocytes and SRBC into lethally irradiated mice were assessed in Day 5 in vitro primary immune responses to SRBC, TNP-SRBC, or TNP-KLH. The pT had more helper activity than the ATC, but pT activity was not manifested as long as ATC activity. The helper activity of 2×10^6 pT was radiosensitive over an extended period after SRBC-activation; therefore, pT radiosensitivity was not temporally related to the time of activation. The helper activities of ATC and 4×10^6 pT were relatively radioresistant, and 500 R enhanced ATC activity. Removal of macrophages from the ATC did not substantially affect their activities before or after irradiation. Addition of macrophages to the pT before or after irradiation enhanced their activity but not back to the level of non-irradiated (OR) pT. The helper activities of the pT and ATC resided in an anti-Thy-1 sensitive population. In fact, the 1000 R-radioresistant ATC were more sensitive to anti-Thy-1 plus complement treatment than non-irradiated ATC. The pT appeared to contain T_1 and T_2 cells, but the ATC possessed the activities mainly of T_1 cells. The evidence suggests that specific help which was the major type provided by pT cells (2×10^6) was radiosensitive, but nonspecific help as induced by Con A and provided by the majority of the ATC was radioresistant.

VERTEBRATES

REFER ALSO TO CITATION(S) 36029, 36094, 36118

36090 (BNL—24069) **Late effects of whole brain irradiation within the therapeutic range.** Caveness, W.F.; Carsten, A.L. (National Institutes of Health, Bethesda, Md. (USA); Brookhaven National Lab., Upton, N.Y. (USA)). 1978. Contract EY-76-C-02-0016. 18p. (CONF-780306—6). NTIS, MF A01.

From Symposium on late biological effects of ionizing radiation; Vienna, Austria (13 Mar 1978).

Portions of document are illegible.

Whole brain exposure with supervoltage x irradiation was carried out in three sets of Macaca mulatta. Two sets of 12 monkeys each, at puberty, received single and fractionated exposures, respectively. One set of 21 monkeys in adulthood received a fractionated exposure. Exposure to 1000 rads in a single dose, at puberty, caused no late effects. Exposure to 1500 rads caused small areas of necrosis in the forebrain white matter at 26 weeks, but a much more extensive involvement at and beyond 52 weeks that included confluent areas of necrosis in gray and white matter. Brain loss resulted in ventricular dilatation. Gliomas appeared in two out of three monkeys at or beyond 52 weeks. Exposure to 2000 rads caused such a wide scatter of focal areas of necrosis, including those in the brain stem, that survival beyond 20 to 26 weeks was not possible. All showed enlarged ventricular systems. Whole brain exposure, 200 rads a day, five days a week, for a course of 4000 rads, at puberty, resulted in no delayed effects. Whole brain exposure to 6000 rads in a six weeks

course, in the adult, produced less effects than the same dose at puberty. The onset of the scattered necrotic lesions was later than expected, appearing in one out of three animals at 33 weeks, two out of three animals at 52 weeks, and two out of three at 104 weeks. The lesions at 104 weeks were predominantly mineralized, but were accompanied by a greater extent of telangiectasia than seen in the pubescent monkeys.

36091 (LA-UR—78-681) **Late biological effects of ionizing radiation as influenced by dose, dose rate, age at exposure, and genetic sensitivity to neoplastic transformation.** Spalding, J.F.; Prine, J.R.; Tietjen, G.L. (Los Alamos Scientific Lab., N.Mex. (USA)). 1978. Contract W-7405-ENG-36. 11p. (CONF-780306—4; IAEA-SM—224/201). Dep. NTIS, PC A02/MF A01.

From Symposium on late biological effects of ionizing radiation; Vienna, Austria (13 Mar 1978).

A most comprehensive investigation is in progress at the Los Alamos Scientific Laboratory to study the late biological effects of whole-body exposure to gamma irradiation as they may be influenced by total dose, dose rate, age at exposure, and genetic background. Strain C57B1/6J mice of four age groups (newborn, 2, 6, and 15 months) were given five doses (20, 60, 180, 540, and 1620 rad) of gamma rays, with each dose being delivered at six dose rates (0.7, 2.1, 6.3, 18.9, 56.7 rad/day and 25 rad/min). Forty to sixty mice were used in each of the approximately 110 dose/dose-rate and age combinations. The study was done in two replications with an equal number of mice per replication. Strain RF/J mice were used in a companion study to investigate the influence of genetic background on the type and magnitude of effect. Results of the first and second replications of the 15-month-old age group and data on the influence of genetic background on biological response have been completed, and the results show no significant life shortening within the dose and dose-rate range used.

36092 **Mammary and other tumors as a response to radiation and multiple stresses.** Warren, S.; Brown, C.E. (Cancer Research Inst., Boston). *Arch. Pathol. Lab. Med.;* **102**: No. 5, 224-226(May 1978).

From American industrial hygiene 1977 conference; New Orleans, LA, USA (26 May 1977).

Parabiosis of paired NEDH rats and subsequent irradiation of one produced multiple stresses, particularly altered hormonal milieu. Benign mammary tumors developed in 8.6% of the control pairs, 12.7% of the shielded partners, and 19.7% of the irradiated rats. Mammary cancers developed in 5% of control pairs, 14.2% of the shielded partners, and 11.9% of the irradiated rats. With increased amounts of prolactin, the rate was 50% in shielded partner, 10% in the irradiated rats. Mesenchymal sarcomas develop at the anastomosis in parabiont rats. Their incidence rate in single controls is 3.1%, in parabiont control pairs 12.5%, in pairs with one partner irradiated 16.6%, and with both irradiated 23.1%. The incidence rate in other parts was increased threefold over controls in the irradiated partners. Radiation appears to be the dominant factor in both mammary and anastomotic tumors.

RADIONUCLIDE EFFECTS - INTERNAL SOURCE

MAN

36093 (EML—333) **Working level dosimeter for uranium miners.** Breslin, A.J.; Guggenheim, S.F.; George, A.C.; Graveson, R.T. (Department of Energy, New York (USA). Environmental Measurements Lab.). Dec 1977. 18p. Dep. NTIS, PC A02/MF A01.

A working level dosimeter for uranium miners has been developed and thoroughly tested. Detection is by an alpha-sensitive thermoluminescent phosphor positioned directly in front of a membrane filter through which sample air is drawn continuously at a rate of 90 cm^3/min. Response is linear over several decades of cumulative working level exposure and the limit of sensitivity is about 1.4 WL-h. Attainment of a critical design objective, reliable operation in the adverse environmental conditions of a uranium mine, has been verified by extensive field tests.

NUCLIDE KINETICS AND TOXICOLOGY

MAN

REFER ALSO TO CITATION(S) 36028, 36086, 36088

ANIMALS

36094 (FMI—44, pp 28-32) **Medical physics and radiobiology.** 1977.

In Annual report, 1977.

Results are reported from studies on erythrocyte formation in mice following administration of various doses of ^{89}Sr. The effects of splenectomy, plasma from very anemic donors, and partially purified erythropoietin, and hypoxic stress on the response to ^{89}Sr irradiation were studied. The effects of fission neutrons from a ^{252}Cf source implant on the growth of a fibrosarcoma located on the back of a mouse were studied as a function of neutron doses and spectra within the tumor. The efficiency of several neutron detectors for dose measurement was evaluated.

36095 (LA-UR—78-644) **Tumor production in Syrian hamsters following inhalation of PuO_2—ZrO_2 aerosol.** Thomas, R.G.; Smith, D.M. (Los Alamos Scientific Lab., N.Mex. (USA)). 1978. Contract W-7405-ENG-36. 13p. (CONF-771109—98). Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; San Francisco, CA, USA (27 Nov 1977).

Syrian golden hamsters of both sexes were exposed to aerosols of ZrO_2 containing PuO_2. The starting material in the aerosol generator also had a small amount of ^{57}Co added as a tracer. The mixture of all three constituents was nebulized and the droplets passed through a heating column at 1000°C. Aerosol sampling was accomplished with a cascade impactor and electrostatic precipitator. The median aerodynamic diameters in all inhalation runs were approximately 2 μm with a geometric standard deviation of 2. One exposed group of 60 hamsters had 6-day lung burdens averaging 100 nCi. This group had a lung tumor incidence of 44% with an even distribution of adenomas and carcinomas. Two other groups had average 6-day lung burdens of 80 to 90 nCi plus 55 nCi of intravenously injected spheres localized in the lung. These animals had tumor incidences of approximately 30%.

36096 (LF-tr—97) **Experimental study in the rat of the effect of radon on the normal and dust-treated lung.** Chameaud, J.; Perraud, R.; Lafuma, J.; Collet, A.; Daniel-Moussard, H. Translated from *Arch. Mal. Prof. Med. Trav. Secur. Soc.;* **29**: 29-40(1968). 13p. Dep. NTIS, PC A02/MF A01.

Studies in rats showed that radon, when inhaled in amounts in the range of 1×10^{-6} Ci/l, did not have an early toxic action on pulmonary tissue. After an exposure to radon of 150 hours, distributed over a period of six months, the integrity of the parenchyma was completely intact. Delayed action of radon and its daughters was not studied. When radon was given with silica the process of nodal transport of the particles appeared to increase. This acceleration, which was visible histologically, was insufficient to include a change in weight of the particles retained in the lung, as measured chemically. An increase in inflammation of the pulmonary alveoli was noted in the animals subjected to radon and silica particles together. The fibrous lesions obtained in the presence of radon were different from the lesions caused by silica alone. Along with typical nodular lesions there were rather diffuse and scattered fibrous lesions, thickening of the septa, and infiltration of the perivascular and peribronchial sheaths. Also, chemical analysis of the collagen showed that there was less formation of collagen when the radon was combined with the silica.

PLANTS

REFER ALSO TO CITATION(S) 35991

36097 **Availability of cobalt-60 to corn and bean seedlings as influenced by soil type, lime, and DTPA.** Adriano, D.C.; Delaney, M.; Paine, D. (Savannah River Ecology Lab., Aiken, SC). *Commun. Soil Sci. Plant Anal.;* **8**: No. 8, 615-628(1977).

Uptake of ^{60}Co by corn (zea mays) and bush beans (Phaseolus vulgaris) seedlings was affected by plant species, soil type, and soil amendment. Bean leaves preferentially accumulated ^{60}Co in comparison with corn leaves. Both the DTPA and (lime and DTPA) treatments enhanced ^{60}Co uptake by both plant species, notably in the Troup soil which had lower cation exchange capacity (CEC) and lower soil fertility in comparison with Dothan soil. Conversely, soils with lime but without the chelating agent suppressed ^{60}Co uptake. This dictates that farming practices should be closely evaluated if crops for livestock and human consumption are to be raised in fields contaminated by radionuclides.

THERMAL EFFECTS

INVERTEBRATES

36098 **Heart rate response to rapid temperature changes in various marine and brackish water crustaceans.** Spaargaren, D.H.; Achituv, Y. (Netherlands Inst. for Sea Research, Texel). *Neth. J. Sea Res.;* **11**: No. 1, 107-117(1977).

The study tries to compare the response on rapid temperature changes in various crustaceans inhabiting different habitats to see whether the type of adjustment is related with the stability of the environment. Heart rate, which is believed to be a sensitive (although non-specific) index of the condition of the animal, is chosen as indicator of adjustment to temperature change.

CHEMICALS METABOLISM AND TOXICITY

REFER ALSO TO CITATION(S) 34400, 34415

36099 (EPRI-EA—668) **Nitrogen oxides: current status of knowledge. Final report.** Colucci, A.V.; Simmons, W.S. (Greenfield, Attaway and Tyler, Inc., San Rafael, Calif. (USA)). Feb 1978. 198p. Dep. NTIS, PC A09/MF A01.

The report reviews the current state of knowledge regarding the health effects of nitrogen oxides, including nitric oxide, nitrogen dioxide, nitrites, nitrates, peroxacyl nitrates, and N-nitrosoamines. A critical review is provided of existing toxicological, human clinical and epidemiological assessment methodologies and data. Special consideration is given to the identification and explanation of the controversial issues surrounding health effects which have been related to ambient levels of NO_2/NO. Evaluation of existing information on the effects of suspended nitrates and airborne nitrosoamines is emphasized. Suggestions are offered for future research programs involving the health effects of nitrogen oxides.

CELLS

REFER ALSO TO CITATION(S) 36033, 36048, 36124

36100 (CONF-780227—4) **Cell-mediated mutagenesis by chemical carcinogens.** Huberman, E.; Langenbach, R. (Oak Ridge National Lab., Tenn. (USA)). 1978. Contract W-7405-ENG-26. 14p. Dep. NTIS, PC A02/MF A01.

From Symposium on application of short-term bioassays in the fractionation and analysis of complex environmental mixtures; Williamsburg, VA, USA (21 Feb 1978).

The cell-mediated mutation system, with the proper choice of metabolizing cells, can be used to detect the mutagenic activities of different classes of chemical carcinogens. When fibroblastic cells were used as the metabolizing cells, a correlation between the in vivo carcinogenic activity and the in vitro mutagenic activity of 11 aromatic polycyclic hydrocarbons was observed. When primary liver cells were used as the metabolizing cells, three known liver carcinogens were demonstrated to be mutagenic by the cell-mediated assay, while two non-carcinogenic analogues were not mutagenic. These results from the cell-mediated system suggest that the reactive intermediates of the carcinogens are stable enough to be transferred from the metabolizing cells to the V79 cells. The cell-mediated mutagenesis system is a simple in vitro assay which may simulate the in vivo situation. It was concluded that this approach could be extended to the co-cultivation of cells from other organs or tissues with mutable mammalian cells.

36101 Relationships of quantum mechanical calculations, relative mutagenicity of benzo[a]anthracene diol epoxides, and "Bay Region" concept of aromatic hydrocarbon carcinogenicity. Lehr, R.E.; Jerina, D.M. (National Inst. of Arthritis, Metabolism, and Digestive Diseases Bethesda, MD). *J. Toxicol. Environ. Health;* **2**: No. 6, 1259-1265(Jul 1977).

Evidence supporting the conclusion that 7,8-dihydroxy-9,10-epoxy-7,8,9, 10-tetrahydrobenzo[a]pyrenes are ultimate mutagenic and carcinogenic forms of benzo[a]pyrene (BP) is summarized. Quantum mechanical calculations that predict reactivity of diol epoxides derived from BP and other polycyclic aromatic hydrocarbons are described. The calculations predict that diol epoxides in which the oxirane ring forms part of a "bay region" of a tetrahydrobenzo ring should be the most reactive for a given aromatic hydrocarbon. Experiments with dihydrodiols and diol epoxides from benzo[a]anthracene (BA) are described. The ability to metabolically activate BA 3,4-dihydrodiol to species much more mutagenic than those obtained from other BA dihydrodiols and the much greater mutagenicity of the diastereoisomeric 3,4-diol-1,2-epoxides of 1,2,3,4-tetrahydro BA relative to other diol epoxides of BA are in accord with predictions of the quantum mechanical calculations.

36102 Some aspects of the basic mechanisms of chemical carcinogenesis. Ts'o, P.O.P. (Johns Hopkins Univ., Baltimore). *J. Toxicol. Environ. Health;* **2**: No. 6, 1305-1315(Jul 1977).

An extended summary is presented of current progress in research on the basic mechanism of chemical carcinogenesis conducted in the Division of Biophysics, School of Hygiene and Public Health, at The Johns Hopkins University. The first section concerns the involvement of free radicals in benzo[a]pyrene metabolism and carcinogenesis, the second the relationship between neoplastic transformation and somatic mutation, and the third the changes in DNA sequence organization and gene expression in neoplastic transformation.

36103 Benzo[a]pyrene carcinogenesis: a biochemical selection mechanism. Selkirk, J.K. (Oak Ridge National Lab., TN). *J. Toxicol. Environ. Health;* **2**: No. 6, 1245-1258(Jul 1977).

Separation of the metabolic products of benzo[a]pyrene has been readily accomplished by high-pressure liquid chromatography. This technique is uniquely suited for compounds labile to air and light and for resolving positional isomers of phenolic or other types of oxygenated metabolites of this carcinogen. This procedure has been utilized to separate and compare benzo[a]pyrene activation and detoxification products between rat, mouse, and hamster hepatic microsomes and mouse and hamster embryo cell cultures. While metabolite profiles exhibited the same types of derivatives, marked quantitative variation was observed. Microsomal preparation produced large amounts of noncarcinogenic phenols, while intact cell metabolism favored diol formation. These results are in agreement with reactivation of metabolic diols as substrates for further activation to a more proximate carcinogenic species of benzo[a]pyrene and caution against extrapolating metabolic results from any single test system to other species or tissues.

MICROORGANISMS

REFER ALSO TO CITATION(S) 36062

36104 Mechanism of poliovirus inactivation by ammonia. Ward, R.L. (Sandia Labs., Albuquerque, NM). *J. Virol.;* **26**: No. 2, 299-305(May 1978).

Poliovirus inactivation by ammonia causes a slight reduction in the sedimentation coefficients of viral particles, but has no detectable effect on either the electrophoretic pattern of viral capsid proteins or the isoelectric points of inactivated particles. These virions still attach to cells, but are unable to repress host translation or stimulate the synthesis of detectable amounts of viral RNA. Although ammonia has no detectable effect on naked poliovirus RNA, it causes cleavage of this RNA when still within viral particles. Therefore, the RNA genome appears to be the only component of poliovirus significantly affected by ammonia.

PLANTS

REFER ALSO TO CITATION(S) 36058, 36122

36105 Light-dependent emission of hydrogen sulfide from plants. Wilson, L.G.; Bressan, R.A.; Filner, P. (Michigan State Univ., East Lansing). *Plant Physiol.;* **61**: No. 2, 184-189(Feb 1978).

With the aid of a sulfur-specific flame photometric detector, an emission of volatile sulfur was detected from leaves of cucumber (Cucumis sativus L.), squash and pumpkin (Cucurbita pepo L.), cantaloupe [Cucumis melo L.), corn (Zea mays L.), soybean [Glycine max [L.] Merr.) and cotton (Gossypium hirsutum L.). The emission was studied in detail in squash and pumpkin. It occurred following treatment of the roots of plants with sulfate and was markedly higher from either detached leaves treated via the cut petiole, or whole plants treated via mechanically injured roots. Bisulfite elicited higher rates of emission than sulfate. The emission was completely light-dependent and increased with light intensity. The rate of emission rose to a maximum and then declined steadily toward zero in the course of a few hours. However, emission resumed after reinjury of roots, an increase in light intensity, an increase in sulfur anion concentration, or a dark period of several hours. The emission was identified as H_2S by the following criteria: it had the odor of H_2S; it was not trapped by distilled H_2O, but was trapped by acidic $CdCl_2$ resulting in the formation of a yellow precipitate, CdS; it was also trapped by base and the contents of the trap formed methylene blue when reacted with N,N-dimethyl-p-phenylenediamine and Fe^{3+}. H_2S emission is not the cause of leaf injury by SO_2, since bisulfite produced SO_2 injury symptoms in dim light when H_2S emission was low, while sulfate did not produce injury symptoms in bright light when H_2S emission was high. The maximum rates of emission observed, about 8 nmol min^{-1} g fresh $weight^{-1}$, are about the activity that would be expected for the sulfur assimilation pathway of a normal leaf. H_2S emission may be a means by which the plant can rid itself of excess inorganic sulfur when HS^- acceptors are not available in sufficient quantity.

36106 Inhibition of light modulation of chloroplast enzyme activity by sulfite. One of the lethal effects of SO_2. Anderson, L.E.; Duggan, J.X. (Univ. of Illinois, Chicago). *Oecologia (Berlin);* **28**: No. 2, 147-151(1977).

The capacity of a particulate pea (Pisum sativum L.) leaf chloroplast system for light-modulation of enzyme activity is diminished by brief exposure to sodium sulfite and, when intact seedlings are exposed to atmospheric SO_2, the same system is inactivated. The destructive effect of this pollutant on green plants may therefore be due to disruption of the mechanism for control of carbon dioxide fixation.

36107 Lead concentrations in algae and plants grown over lead contaminated sediments taken from snow dumps in Ottawa, Canada. Milne, J.B.; Dickman, M. (Univ. of Ottawa). *J. Environ. Sci. Health, Part A;* **12**: No. 4-5, 173-189(1977).

Lead, which has been identified as a constituent of automobile exhaust, was found associated with sediments in snow dump areas in Ottawa. Lead levels in these sediments were over an order of magnitude above those of uncontaminated sediments. Algae and aquatic plants exposed to these same lead contaminated sediments over a 2 to 4 month period were shown to have higher lead concentrations than those grown over control sediments. Evidence presented suggests that soluble lead was actively concentrated by both the attached and free floating (planktonic) algae and, to a lesser extent, the higher aquatic plant Vallisneria americana.

INVERTEBRATES

36108 Effects of the water-soluble fraction of Ekofisk crude oil on zoeal larvae of the crab Hyas araneus. Christiansen, M.E. (Univ. of Oslo); Stoermer, F.C. *Ambio;* **7**: No. 1, 23-25(1978).

Effects of the water soluble fraction of Ekofisk crude oil were tested on zoeal larvae of the brachyuran crab Hyas araneus (Linnaeus). The water soluble fraction had no acute effect on survival at concentrations of 0.3, 1.5, and 3.0 ppM hydrocarbons. A long-term effect on survival was observed at the 3.0 ppM concentration. While 95 to 100 percent of the first zoeal larvae survived to the megalopa stage in the control and in the two lower concentrations of hydrocarbons, only 25 percent reached this stage at 3.0 ppM. It was also found that the duration of zoeal development lengthened significantly with an increase in hydrocarbon concentrations.

VERTEBRATES

REFER ALSO TO CITATION(S) 36025, 36029, 36052, 36053, 36096

36109 (LA—7208-MS) **Dominant lethal assay for bis-dinitropropyl-formal: bis-dinitro-propyl-acetal and kerimide 601 resin.** Wilson, J.S.; Smith, D.M. (Los Alamos Scientific Lab., N.Mex. (USA)). Mar 1978. Contract W-7405-ENG-36. 7p. Dep. NTIS, PC A02/MF A01.

Bis-dinitro-propyl-formal:bis-dinitro-propyl-acetal (BDNPF:BDNPA) and kerimide 601 resin do not appear to be mutagenic at the doses utilized when introduced intragastrically either as an acute or chronic insult in vivo. It should be pointed out that the dominant lethal assay has limitations. It has been observed by others that positive data with Ames testing can give negative data with this method. To produce a strong mutagenic effect detectable by the dominant lethal assay, there must be considerable chromosome damage in the sperm. The dominant lethal assay does not detect point mutations or low incidence of chromosome breakage. The assay can be valuable in expressing the in vivo effect, which can be contrary to in vitro studies, and should be considered in a total toxicity survey of a chemical. Using the dominant lethal assay, one can screen out a positive mutagen, but lack of an effect does not indicate that the chemical is not mutagenic. It is either not mutagenic or the assay is not specific enough to detect the in vivo effect.

36110 Possible mechanism for cadmium-induced hypertension in rats. Revis, N. (Oak Ridge National Lab., TN). *Life Sci.;* **22**: No. 6, 479-488(13 Feb 1978).

The mechanism of cadmium-induced hypertension was explored by measuring noradrenaline metabolism. Cadmium in vitro was shown to inhibit both monoamine oxidase and catechol-O-methyltransferase, the two enzymes which inactivate the neurotransmitters noradrenaline and adrenaline. However, rats which were injected or fed (via the drinking water) with cadmium showed that, among the tissues surveyed, these two enzymes were inhibited significantly only in the aorta. In vitro, cadmium was found to inhibit noradrenaline binding to membranes from the heart, lung, and kidney, while stimulating binding to aortic membranes, which suggests that the effects may be specific. These results suggest that, in the aorta, cadmium may inhibit the two catabolic enzymes of noradrenaline, while at the same time stimulating noradrenaline-binding. Thus the effects of noradrenaline on vascular smooth muscle would be increased as well as prolonged.

36111 Acute lung injury induced by cadmium aerosol. II. Free airway cell response during injury and repair. Asvadi, S.; Hayes, J.A. (Boston Univ. School of Medicine). *Am. J. Pathol.;* **90**: No. 1, 89-96(Jan 1978).

This paper presents a study of the effects of cadmium chloride aerosol on free airway cell populations. Rats were given a single exposure to aerosolized 0.005 M $CdCl_2$ dissolved in physiologic saline. $CdCl_2$ exposure induced a fivefold increase to 43.2×10^6 total cells at 4 days as compared with 11.1×10^6 in saline-exposed controls and 8.4×10^6 in unexposed rats ($P < 0.001$). Differential counts showed a peak of polymorphonuclear leukocytes (PMN) at 3 days after $CdCl_2$ exposure, whereas values for saline-exposed animals showed no change from values for unexposed animals ($P < 0.001$). Four days after $CdCl_2$ exposure the predominant cell was the alveolar macrophage (AM), which showed a highly significant increase in number and size over saline-exposed and unexposed animals. A significant increase in lymphocytes also occurred, with a peak at 4 days. At 10 days after exposure, AM were still more numerous after $CdCl_2$ exposure ($P < 0.001$), but all other cell types had returned to control levels. Correlation with previous ultrastructural studies on $CdCl_2$ exposure suggested the peak of PMN coincided with Type I cell necrosis. In contrast, AM predominated during the repair phase of injury, in which Type II cell proliferation and phagocytosis occur.

36112 Absorption of mercury from ligated segments of the rat gastrointestinal tract. Sasser, L.B.; Jarboe, G.E.; Walter, B.K.; Kelman, B.J. (Comparative Animal Research Lab., Oak Ridge, TN). *Proc. Soc. Exp. Biol. Med.;* **157**: No. 1, 57-60(Jan 1978).

The ligated segment technique was used to compare the gastrointestinal absorption of methylmercury and mercury chloride in the rat. Methylmercury was more readily absorbed (15 to 35 times greater, depending on the absorption site) than inorganic mercury from all ligated segments. The relative order of methylmercury absorption from ligated segments was as follows: duodenum > stomach = ileum > jejunum. Differences in absorption of inorganic mercury between gastrointestinal segments were not observed. Endogenous excretion of both forms of mercury into intestinal tissue were equal. The data indicate that the absorption of methylmercury from the stomach is significant relative to other parts of the gastrointestinal tract and that the stomach must be considered a major site of absorption.

36113 WHO environmental health criteria for mercury. *Ambio;* **7**: No. 1, 28-30(1978).

The summary of the Environmental Health Criteria document for mercury is presented in agreement with the World Health Organization. Included in the summary are: analytical methods, sources of pollution, environmental distribution and transport, exposure levels, metabolism and biological effects of mercury, epidemiological and clinical studies, health risks, and recommendations for further research.

36114 WHO environmental health criteria for polychlorinated biphenyls and terphenyls. *Ambio;* **7**: No. 1, 31-32(1978).

The environmental impact of the PCBs and PCTs has been the subject of several reviews, and has been discussed at a number of regional and international meetings. A summary of the World Health Organization's Environmental Health Criteria Document for polychlorinated biphenyls and terphenyls is presented.

36115 Synergistic teratogenic effects of arsenic and hyperthermia in hamsters. Ferm, V.H.; Kilham, L. (Dartmouth Medical School, Hanover, NH). *Environ. Res.;* **14**: No. 3, 483-486(Dec 1977).

Similar malformations of the central nervous system including encephaloceles and exencephaly are induced by treatment of pregnant hamsters with sodium arsenate or hyperthermia on the eight day of gestation. These two treatments are synergistic in that combinations of minimal teratogenic levels of each cause a marked increase in fetal resorptions and the frequency and severity of developmental malformations as compared to separate treatments. The possible relationship of maternal hyperpyrexia and environmental teratogens to congenital malformations is discused.

36116 Differential effects of free and combined chlorine on juvenile marine fish. Capuzzo, J.M. (Woods Hole Oceanographic Institution, MA); Davidson, J.A.; Lawrence, S.A.; Libni, M. *Estuarine Coastal Mar. Sci.;* **5**: No. 6, 733-741(Nov 1977).

The differential effects of free chlorine and chloramine on three species of juvenile marine fish have been investigated in continuous flow bioassay units. The toxicity of both chlorine forms to winter flounder, Pseudopleuromectes americanus, scup, Stenotomus versicolor, and killifish, Fundulus heteroclitus, appeared to be a threshold effect: an abrupt increase in mortality was observed over a narrow range of toxicant concentrations. The three species were similar in their responses to free chlorine, the more toxic of the two chlorine forms. However, there was a difference in chloramine toxicity among the three species tested; killifish were more susceptible than either of the other two species, probably reflecting differences in metabolic regulation or uptake rates. Behavioral aberrations—distended gills and erratic swimming behavior—of winter flounder and scup and significant reductions in standard respiration rates of killifish were observed with exposure to chlorine or chloramine concentrations approaching lethal levels.

36117 Effect of polychlorinated biphenyl (PCB) on the thyroid gland of rats: ultrastructural and biochemical investigations. Collins, W.T. Jr.; Capen, C.C.; Kasza, L.; Carter, C.; Dailey, R.E. (Ohio State Univ., Columbus). *Am. J. Pathol.;* **89**: No. 1, 119-130(Oct 1977).

Polychlorinated biphenyls (PCB) produced ultrastructural lesions in thyroid follicular cells and reductions in serum thyroxine levels in rats that were time- and dose-dependent. The acute effects (4 week) of PCB (50 and 500 ppM) consisted of an accumulation of lysosomal bodies and colloid droplets in follicular cells with abnormalities of microvilli on the luminal surface. The chronic administra-

tion (12 week) of PCB (50 and 500/250 ppM) resulted in a striking distention of many follicular cells with large lysosomal bodies with strong acid phosphatase activity and colloid droplets, blunt and abnormally branched microvilli, and mitochondrial vacuolation. These ultrastructural alterations in follicular cells were associated with a highly significant reduction in serum thyroxine with both the low and the high dose of PCB. Follicular cells remained responsive to the lowered thyroxine level after feeding PCB for 4 and 12 weeks and underwent moderate compensatory hypertrophy and hyperplasia. Thyroid follicles were smaller than in controls and were lined by more columnar cells that occasionally formed papillary projections into the colloid. Residual ultrastructural alterations persisted for 12 weeks following cessation of feeding the compound, and serum thyroxine levels were significantly lower than in control rats. However, 35 weeks after discontinuing PCB, thyroid follicular cells were similar to those in controls and serum thyroxine levels had returned to normal. The striking ultrastructural lesions in follicular cells produced by feeding PCB to rats appeared to contribute to the lowering of serum thyroxine levels, in combination with the known stimulation of peripheral thyroxine metabolism by these compounds. Certain metabolic alterations produced by PCB intoxication in experimental animals and human beings may be related to an alteration in thyroid function.

36118 Repair of DNA damage induced by ionizing radiation and benzo[a]pyrene in mammalian cells. Cerutti, P.; Shinohara, K.; Remsen, J. (Univ. of Florida, Gainesville). *J. Toxicol. Environ. Health;* **2**: No. 6, 1375-1386(Jul 1977).

The biological effects of DNA-damaging agents are codetermined by the structural characteristics of the lesions, the quality and extent of the local distortion of DNA and chromatin structure, and the mode(s) of damage processing used by a given type of cell. Persistent damage (i.e., damage that is not removed before it is reached by DNA replication) may be mostly responsible for mutagenesis and carcinogenesis. To understand the effects of environmental physical and chemical DNA-damaging agents on human health, the mechanisms of damage processing used by human cells have to be elucidated. We report our studies of the excision of gamma-ray products of the 5,6-dihydroxydihydrothymine type (t_0/sub 2//sup γ/) in normal human fibroblasts and in fibroblasts from patients with the hereditary diseases Fanconi's anemia (FA) and ataxia telangiectasia (AT). Both diseases are characterized by chromosomal instability and increased susceptibility for the development of cancer. Formation and repair of DNA-benzo[a]pyrene adducts were studied in baby hamster kidney cells, secondary mouse embryo cells, and human lymphoma. The relative persistence of DNA-B[a]P may explain the high mutagenicity of the 7,8-dihydroxy-9,10-epoxytetrahydrobenzo[a]pyrene metabolites in rodent cells that has been observed by several investigators.

36119 Pathological alterations in Syrian golden hamster lungs after passive exposure to cigarette smoke. Ketkar, M.B.; Reznik, G.; Mohr, U. (Abteilung fuer Experimentelle Pathologie, Hanover). *Toxicology;* **7**: No. 3, 265-273(Jun 1977).

The effects of 2 types of research cigarettes, differing in their total smoke delivery and condensate, were examined as to their histopathological effects on Syrian golden hamster lungs. The animals were passively exposed to the total smoke of the cigarettes once a day, 5 days/week for 1 year. Experimental and control animals were killed one day after termination of exposure. Varying effects on the macrophages of pulmonary alveolar tissue were observed. Infiltration of lung tissue by "Brown cells" was a common pathological alteration. Qualitative and quantitative differences existed between the two cigarette groups with respect to the occurrence of such "Brown cell" clumps. The response of the lung tissue to smoke exposure would appear to be dependent upon the amount of mainstream total particulate matter (TPM), the amount of condensate, the time exposed and the number of cigarettes.

36120 Effects of different routes of administration and injection schedules of thrombopoietin on ^{35}S incorporation into platelets of assay mice. McDonald, T.P. (Univ. of Tennessee Memorial Research Center, Knoxville). *Proc. Soc. Exp. Biol. Med.;* **155**: No. 1, 4-7(May 1977).

The 24-hr percentage of ^{35}S incorporation into platelets of mice in rebound thrombocytosis was compared after single or multiple sc and ip injections of a thrombopoietin (TSF)-rich preparation. TSF administered sc or ip resulted in almost identical percentage of ^{35}S incorporation values. Various doses of TSF injected sc two times on Day 5 after RAMPS and two times again on Day 6 gave a linear dose-response curve. Also, this injection schedule gave the greatest response to the same total dose of TSF when compared to other injection schedules. Single injections of TSF did not give as great a response as did multiple injections using the same total dose. Results of this work indicate that for maximum percentage of ^{35}S incorporation values, TSF-rich materials should be administered in multiple injections to mice, either sc or ip, over a period of approximately 2 days.

36121 Observations on mouse chromosomes following nitrogen dioxide inhalation. Gooch, P.C.; Luippold, H.E.; Creasia, D.A.; Brewen, J.G. (Oak Ridge National Lab., TN). *Mutat. Res.;* **48**: 117-120(1977).

Observations are reported on the chromosomes of mouse leukocytes and spermatocytes following inhalation of nitrogen dioxide. The present occupational threshold limit value for NO_2 is 5 ppM. C3H male mice were exposed to 0.1, 1, 5, and 10 ppM of NO_2 for 6 h. The concentrations were produced by dilution of certified NO_2 with clean, filtered air and confirmed by monitoring with an NO_2 analyzer using the chemiluminescent technique. The results of leucocyte chromosomal analysis showed no increase in either chromatid- or chromosome-type aberrations for any of the exposures tested. The analysis of the primary spermatocytes also showed no effect of the treatment. (MFB)

36122 Interactive effect of chromium compounds and a fungal parasite on carp eggs. Draggan, S. (Oak Ridge National Lab., TN). *Bull. Environ. Contam. Toxicol.;* **17**: No. 6, 653-659(1977).

A fungal parasite (Saprolegniales) of carp eggs was exposed to hexavalent and trivalent chromium compounds at concentrations identical to those used in a study of the effects of the same compounds on carp egg hatchability. Comparison of data from both experiments revealed that increased egg mortality and increased fungal growth were coupled at low concentrations of the compounds. A mechanism for the interaction of a chemical stress and a biological stress on carp egg survival in natural systems is presented.

36123 (BNWL-tr—302) Effect of low concentrations of carbon disulfide and hydrogen sulfide on intrauterine development in rats. Barilyak, I.R.; Vasil'eva, I.A.; Kalinovskaya, L.P. Translated from *Arkh. Anat., Gistol. Embriol.;* **68**: No. 5, 77-80(1975). 9p. Dep. NTIS, PC A02/MF A01.

Male and female rats were exposed to low concentrations of carbon disulfide and hydrogen sulfide for 70 to 90 days and then were mated. In a second series, females only were exposed and in a third series, males only were exposed. On the 20th day of pregnancy fetuses were removed and histological preparations were made. Observations were made on fetal growth, teratogenesis, and ossification. Carbon disulfide and hydrogen sulfide brought about disruptions of morphogenesis of liver and kidneys exhibited principally in retardation of the differentiation of hematopoietic elements of the liver and in an increasing number of cells of the megakaryoblast series. These changes are coupled with vascular pathology. (HLW)

MAN

REFER ALSO TO CITATION(S) 36050, 36051

36124 (ORNL-tr—4593) Osmotic resistance of red blood cells of venous blood in miners from depth uranium-ore mines; its changes caused by uranyl and lead ions. Nosek, J.; Bartonova, H. Translated from *Cas. Lek. Cesk.;* **115**: No. 27, 828-829(9 Jul 1976). 4p. Dep. NTIS, PC A02/MF A01.

The osmotic resistance of erythrocytes of venous blood of uranium miners was found to be lower than that of control subjects. Length of employment and depth of the mine both contributed to the change. In in vitro studies the addition of uranyl salts to suspensions of erythrocytes lowered the osmotic resistance while the addition of Pb ions increased resistance of the cells to osmotic hemolysis.

36125 Metodi di analisi per la determinazione dei metalli nei liquidi biologici. (Methods of analysis for the determination of metals in biological fluids). Pozzoli, L.; Minoia, C.; Angeleri, S. Pavia, Italy; Editions Aurora, Legatoria Cartotecnical di Ge Carla (1976). 331p.

Contents of this textbook: techniques and apparatus used; characteristic parameters; preparation of standard solutions; calibration; definitions; determination of the following metals in blood and/or urine (by atomic absorption spectrometry); aluminium, arsenic, cadmium, cobalt, chromium, copper, iron, manganese, mercury, nickel, lead, zinc.

OTHER ENVIRONMENTAL POLLUTANT EFFECTS

REFER ALSO TO CITATION(S) 34493

36126 Effect of pulsed solid laser radiation on the internal ear of animals. Pokotilenko, A.K.; Timen, G.E. *Zh. Ushnykh Nosovykh Gorlovykh Bolez.;* No. 2, 30-35(1976). (In Russian).

The bony capsule of the labyrinth of 20 rabbits and cats was exposed to pulsed laser radiation (100 to 17,000 j/cm^2) and the resulting changes in the internal ear were examined immediately after irradiation and periodically during the next 60 days. The extent of destruction and subsequent repair were found to be directly

related to the power density. Exposure to 100 j/cm² caused a "flattening" of the cochlea, deformation of the basilar and Reissner's membranes and other changes in the ductus cochlearis and semicircular canals; all these changes were largely reversed before the end of the observation period. On the other hand, exposure of the promontorium to 17,000 j/cm² resulted in charring and perforation of the bone and permanent deformation of the membranous labyrinth.

GEOSCIENCES

GEOLOGY AND HYDROLOGY

REFER ALSO TO CITATION(S) 34524, 34528, 34770, 35944, 35945, 35952, 35953, 35954, 35955, 35959, 35960, 35961, 35962

36127 (LBL—6363) **Measurement of soil properties in-situ. Present methods: their applicability and potential.** Mitchell, J.K.; Guzikowski, F.; Villet, W.C.B. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1978. Contract W-7405-ENG-48. 70p. Dep. NTIS, PC A04/MF A01.

The measurement of soil properties in-situ offers the advantages of minimal disturbance, retention of the in-situ state of stress, temperature, chemical, and biological environments, and cost effectiveness relative to many types of laboratory tests for evaluation of undisturbed soil properties. This report is concerned with techniques for in-situ measurement of permeability, strength, stress-deformation properties, and volume change properties; property classes which are of interest in most geotechnical engineering problems. Emphasis is on test concepts, data analysis and interpretation, and advantages and limitations of methods, as opposed to details of apparatus and procedure.

36128 **Regional geotherms and lithospheric thickness.** Chapman, D.S. (Univ. of Utah, Salt Lake City); Pollack, H.N. *Geology;* **5**: No. 5, 265-268(May 1977).

Continental and oceanic geotherm families parametric in surface heat flow intersect the mantle solidus at a depth coincident with the top of the seismic low-velocity zone, thus allowing surface heat-flow variations to be used to map the thickness of the lithosphere on a global scale. Thermal models were developed that predict a lithospheric thickness of a few tens of kilometers in young oceans and continental orogenic provinces and more than 300 km in shield areas. The variable thermal structue of the mantle implies a greater viscosity beneath shields, which offers an explanation for the observed retarded motions of plates that bear shields.

GEOPHYSICS

SEISMOLOGY AND TECTONICS

REFER ALSO TO CITATION(S) 34771

36129 (NUREG—0402) **Analysis of a worldwide strong motion data sample to develop an improved correlation between peak acceleration, seismic intensity, and other physical parameters.** Murphy, J.R.; O'Brien, L.J. (Computer Sciences Corp., Falls Church, Va. (USA)). Sep 1977. 99p. NTIS $6.50.

Results of a continuing investigation of the correlations between seismic intensity and ground motion are reported. An updated strong motion sample consisting of data measured from nearly 1600 accelerograms forms the basis for these investigations. Statistical analyses of these data have yielded correlation equations. They indicate a dependence of the acceleration/intensity correlation on magnitude, epicentral distance and possibly the geographical region or tectonic province in which the earthquakes are occurring. The difficult problem of identifying and explaining regional anomalies in the acceleration/intensity correlation is addressed and evidence is presented which suggests that the Southern European anomaly may be related to the fact that the spectral composition of the near-field ground motions measured in Southern Europe are unusual and that this may reflect regional differences in the dynamic characteristics of the earthquake sources. The influence of local site geology on the acceleration/intensity correlation has also been examined in more detail, including the measured effects at a specific station in New Guinea at which an unusually large peak acceleration amplification has been identified and documented. It has been concluded that the local amplification of the peak acceleration is generally controlled by the overburden thickness at the site, due to the fact that the peak acceleration pulse is attenuated as it propagates through the imperfectly elastic layer of alluvium. A new correlation equation in which the magnitude variable is replaced by epicentral intensity is derived for purposes of applications to the assessment of historical earthquakes for which no instrumentally determined magnitudes are available. Preliminary results suggest that intensity may be much more strongly correlated with response spectral amplitudes in narrow period bands than with any single peak ground motion parameter.

36130 (USGS—474-184) **Seismicity of the Pahute Mesa area, Nevada Test Site, October 8, 1975 to June 30, 1976.** Rogers, A.M.; Wuollet, G.M.; Covington, P.A. (Geological Survey, Las Vegas, Nev. (USA)). 1977. Contract EY-76-A-08-0474. 66p. Dep. NTIS, MF A01.

Portions of document are illegible.

A total of 1,075 earthquakes occurred in the Pahute Mesa area during the period October 28, 1975, to June 28, 1976. The majority of these earthquakes are aftershocks of the nuclear events, Kasseri, Inlet, Muenster, Fontina, Cheshire, Estuary, Colby, and Pool. Smaller nuclear events on Rainier Mesa and Yucca Flat detonated in the same time period did not trigger aftershock sequences. The aftershock series were displaced laterally from ground zero and occurred deeper (at 4-6 km) than the nuclear event depth of burial (approximately 1 km). The aftershocks appear to occur on vertical faults with approximately north-south strike. The number of aftershocks following each nuclear event generally declined as the testing program progressed (for instance, Kasseri triggered twice as many events as Colby). Comparison of this series with the 1968-70 nuclear test series shows that Benham triggered about nine times the number of aftershocks associated with Kasseri. Aftershock b-values were lower during this series than the 1968-70 series.

36131 (USGS—474-255) **Method for obtaining confidence-limit values for seismic velocities calculated from Vibroseis data.** Muller, D.C.; Brethauer, G.E. (Geological Survey, Denver, Colo. (USA)). Mar 1978. Contract EY-76-A-08-0474. 13p. Dep. NTIS, PC A02/MF A01.

An equation is derived to calculate the confidence-limit values associated with seismic velocities calculated from time and distance data obtained using the Vibroseis method. This derived equation is a function of the uncertainty in the time measurement. Sources of timing uncertainty in the Vibroseis method are examined and estimates of the timing uncertainty are made. These estimates of the uncertainty in the time measurement are used to calculate the confidence-limit values associated with calculated velocities. A nomograph has been constructed to provide quick approximation of these confidence-limit values. The Vibroseis method is used in the nuclear weapons testing program to determine seismic velocities in various areas at the Nevada Test Site. These seismic velocities are used as parameters in ground motion and cavity growth models and as indicators of possible high acoustic-impedance boundaries. It is important to have some estimate of the uncertainty associated with these seismic velocities.

36132 **Determination of the three-dimensional seismic structure of the lithosphere.** Aki, K. (Massachusetts Inst. of Tech., Cambridge); Christoffersson, A.; Husebye, E.S. *J. Geophys. Res.;* **82**: No. 2, 277-296(10 Jan 1977).

A new three-dimensional earth modeling is proposed as a framework to obtain more detailed and accurate information about the earth's interior. The study was begun with a layered medium of classic seismology, but each layer was divided into many blocks and a parameter assigned to each block, which describes the velocity fluctuation from the average for the layer. Data are the teleseismic P travel time residuals observed at an array of seismographs distributed on the surface above the earth's volume we are modeling. By isolating various sources of errors and biases a system of equations was developed to determine the model parameters. The solution was obtained by the use of generalized inverse and stochastic inverse methods. The method also gives a lower limit of the true rms slowness fluctuation in the earth under the assumption of ray theory. Using P wave residual data from the Norwegian Seismic Array (Norsar), the map of velocity anomalies at various depths up to a depth of 126 km was obtained. The rms slowness fluctuation was found to be at least 3.1%. This is in agreement with estimates obtained from statistical analysis of P time fluctuations based on the Chernov theory. The three-dimensional velocity anomalies are presented both by the generalized inverse and by the stochastic inverse solutions. The dominant features in the obtained three-dimensional velocity image of the lithosphere beneath the Norsar array are low velocities to the west and high velocities to the east.The latter feature may be attributed to rocks of the Baltic shield which are undisturbed by the Caledonian orogeny or by Permian volcanism. Results conclusively demonstrate the existence of strong small-scale inhomogeneities to the bottom of the lithosphere. More theoretical and experimental works are needed to relate these velocity anomalies with the magma ascent mechanism which caused the Oslo graben.

36133 Aleutian arc: tectonic blocks, episodic subduction, strain diffusion, and magma generation. Spence, W. (Geology Survey, Denver). *J. Geophys. Res.;* **82**: No. 2, 213-230(10 Jan 1977).

A relocated earthquake sequence in the western Aleutian arc lasting from February 1965 through December 1968 is shown to map an episode of subduction of the Pacific plate. The February 4, 1965, Rat Island main shock (M/sub s/ + 8.1) was a complex rupture involving greatest underthrusting at lock zones beneath the Aleutian arc transverse canyons. The primary tectonic consequences of the main shock rupture were (1) the downslab diffusion of a compressional pulse, (2) the oceanward diffusion of an extensional pulse in the oceanic lithosphere, and (3) the slow rebound of the continental plate. The velocities of these strain pulses (actual plate motions) are determined by the viscosity of the constraining mantle material; observed strain velocities indicate a Newtonian mantle viscosity of 6 x 10^{19} P. The extensional pulse that propagated oceanward is shown to determine the locations and normal-faulting mechanisms of the trench earthquakes of this sequence. It is inferred that the entire subducting oceanic lithosphere contains a sequence of near-vertical faults that strike parallel to the trench axis, reflecting former trench-related normal-faulting earthquakes. This condition is supported by considerable data and suggests a slabbing, escalatorlike descent mechanism for the upper 100 km of the subducting Pacific plate. A working hypothesis is presented that relates the primaryfeatures of the typical volcanic arc and interarc basin to episodic downslab compressional pulses. This hypothesis involves a sequence of high-loading-rate mantle compression, viscoelastic rebound, pressure reduction, increased partial melt concentrations, and counterflow in a thin tabular zone above the subducting plate.

36134 Seismic moments of earthquakes beneath island arcs, phase changes, and subduction velocities. McGarr, A. (Univ. of the Witwatersrand, Johannesburg). *J. Geophys. Res.;* **82**: No. 2, 256-264(10 Jan 1977).

The analysis of seismic moments of intermediate and deep-focus earthquakes in four island arc regions supports the hypothesis that these shocks are the result of shear stresses caused by phase transitions in the descending slab at depth near 150, 350, and 600 km. Cumulative seismic moments summation M_0 for earthquakes listed by Gutenberg and Richter were found to exhibit four maxima when they were plotted as a function of depth; the maxima occur within the depth ranges 0 to 100, 100 to 250, 250 to 450, and 450 to 700 km. The uppermost range corresponds to the zone of underthrusting. The seismic moments of earthquakes in the three lower depth ranges ae related to phase transitions in the slab by summation $M_0 = \mu LT$ vertical bar $\Delta V/V$ vertical bar v/sub sub/, where μ is the modulus of rigidity, L is the length along strike of the subduction zone, T is the slab thickness, $\Delta V/V$ is the fractional volume change associated with a particular phase transition, and v/sub sub/ is the subduction velocity. In the range 100 to 250 km the earthquakes result from volume decreases associated with the melting of the oceanic crust. In the depth range 250 to 450 km the volume change is due mostly to the transformation of olivine to spinel structure with a density increase of about 8%. In the lowest depth range the decrease in volume is due to the change of spinel to postspinel phases with a density increase of about 8%.For any island arc region, up to four independent estimates of v/sub sub/ can be calculated by using Brune's method for the zone of shallow underthrusting and the relationship between summation M_0 and volume changes for the three deeper zones. As an example, the four estimates of v/sub sub/ for the Tonga arc, in order of increasing depth, are 8.4, 7.9, 7.6, and 8.3 cm/yr.

VOLCANOLOGY

REFER ALSO TO CITATION(S) 34774

36135 Source mechanism of volcanic tremor: fluid-driven crack models and their application to the 1963 Kilauea eruption. Aki, K.; Fehler, M.; Das, S. (Massachusetts Inst. of Tech., Cambridge). *J. Volcanol. Geotherm. Res.;* **2**: 259-287(1977).

A model for the mechanism of magma transport is proposed; it is based on a fluid-filled tensile crack driven by the excess pressure of fluid. Such a transport mechanism can generate seismic waves by a succession of jerky crack extensions, if the fracture strength of rock varies in space, or if there is a difference between the dynamic and static values of the critical stress intensity factor. It was found that the opening and closing of a narrow channel connecting two fluid-filled cracks may be a source of seismic waves. Using the finite-difference method, calculations were made on the vibration of dry and fluid-filled cracks generated by: (1) a jerky extension at one end or at both ends and (2) a jerky opening of a narrow channel connecting two cracks. The far-field and near-field radiation from these vibrating cracks was then calculated. The spectra show peaked structures, but interestingly, most high-frequency peaks are only present in the near-field and cannot be transmitted to the far-field. The spectral features described above are often observed for volcanic tremors and in some cases for seismic signals associated with hydraulic fracturing experiments. Considered as a model of volcanic tremor were randomly occurring jerky crack extensions, and a formula was derived relating the tremor amplitude to the excess pressure in the magma, the incremental area in each extension, and the frequency of extensions. It was concluded that a single, long crack extending from the summit to the eruptive site cannot explain the observations. The model of a steadily expanding crack ran into difficulties when quantitative comparisons were made with observations. The extension of crack area needed to explain the amplitude of volcanic tremor should accompany a large increase in tremor period which was not observed. The second model is a chain of cracks connected by narrow channels which open and close.

GEOPHYSICAL SURVEY METHODS

REFER ALSO TO CITATION(S) 34422, 34496, 34551, 34563, 34564, 35910, 35911, 35913, 35915, 35928, 35944, 35945, 35946, 36588

36136 (CONF-7510172—P1, pp 45-46) **EROS Program of the Department of the Interior.** Fischer, W.A.; Hemphill, W.R. (Geological Survey, Reston, VA). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The objectives of the EROS Program are: to undertake research relating to the development and use of remote-sensor systems for resourcess and environmental purposes- to provide training assistance in the use of the data from these sensors to the national and international community of earth scientists and resources managers; to make the data collected by sensor systems available at a reasonable cost, on a timely basis, and to provide guidance on the characteristics and potential benefits of future systems. Research has included three areas: the development of ratioing techniques and other mathematical treatments of digital data derived from the LANDSAT Earth Resources Satellites; the definition of applications of LANDSAT-type data with emphasis in such areas as the recognition and evaluation of large-scale geologic features, mapping of floods, assessment of rangeland condition, measurement of snow distribution, detection of oil on water, and determining the usefulness of the data for mapping land systems and land cover by both manual and semi-automatic techniques; and the development and testing of the Fraunhofer Line Discriminator (FLD), an airborne device that measures the luminescence of natural objects.

36137 (CONF-7510172—P1, pp 53-64) **Interpretation and measurement of multichannel microwave SAR imagery.** Larson, R.W.; Jackson, P.L.; Dallaire, R.J.; Shuchman, R.; Rawson, R. (Environmental Research Inst.. of Michigan, Ann Arbor). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

A discussion of measurements capability, data manipulation techniques and display methods applicable to multichannel microwave synthetic aperture radar (SAR) systems is presented. Examples of four measurements techniques applied to the ERIM 4-channel microwave SAR system are given. A discussion of the large dynamic range capability of the SAR system is included and examples of 4-channel SAR imagery are presented.

36138 (CONF-7510172—P1, pp 65) **Removal of LANDSAT image banding by Fourier domain filtering.** Bumgarner, J.O. (ESL Inc., Sunnyvale, CA). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

A powerful image enhancement technique used in digital image processing is spatial frequency filtering in the Fourier domain. As an application of Fourier image enhancement, a technique for debanding LANDSAT data is offered which involves applying a filter in the Fourier domain to remove the spatial frequency components due to the banding. As a preliminary step the appearance of general image spatial frequencies in the Fourier domain in an image enhancement processing system is discussed and some illustrative examples given. Next the effects of applying various filters to the examples are demonstrated. The appearance of the LANDSAT image banding in the Fourier domain is shown for water and mixed terrain. Finally, the results of using different kinds of Fourier domain filters on the LANDSAT images are presented. Advantages and disadvantages of the three filters are discussed. Some areas of future work are laid out including improved filter design and methods of improving computational efficiency by applying the results of Fourier processing in a representative area to adjust image statistics and sensor calibration over larger areas of the image.

36139 (CONF-7510172—P1, pp 77-84) **Measurement of infrared emission signatures and their application to remote sensing.** Brown, R.J.; Apps, R.G.; Young, B.G. (Defence Research Establishment, Ottawa). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

As remote sensing is used in more varied and comprehensive investigations it becomes quite obvious how lacking in knowledge we are, in many instances, of some of the basic parameters of our "targets." In fact most pattern recognitiion approaches are defeated not by the discrimination algorithms but by the input data. As a consequence we at DREO have embarked upon a program to determine one of these parameters, namely the infrared spectral emission signatures. Such knowledge is essential in the specification of the wavelength band to be used to optimize the probability of detecting a particular object against a particular background or in any study requiring an accurate temperature determination. For example, when sensing within the 8 to 14 μm wavelength band an average emissivity error of 0.05 can result in an incorrect temperature assignment of approximately 3°C. Our approach includes collecting these spectral emission signatures both in the laboratory and in the field using a Fourier transform spectrometer. The laboratory results are intended as a baseline against which to assess environmental effects. At the present time we are concentrating our efforts in the wavelength region where the spectral blackbody emission curve of ambient temperature objects peaks which coincides with the 8 to 14 μm "atmospheric window." Actually our detectors respond to shorter wavelength radiation but the signal-to-noise ratio (SNR) decreases considerably at wavelengths below about 6 μm and hence only gross spectral features can be reliably identified in this wavelength region. This paper provides a brief description of the operation of a Fourier transform spectrometer and discussions of some of the spectra collected.

36140 (CONF-7510172—P1, pp 159-162) **Synchronous meteorological satellite (SMS): its advantages and applications.** Scofield, R.A.; Oliver, V.J. (National Environmental Satellite Service, Washington, DC). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The use of cloud photographs, taken 24 hours-a-day, is now an essential part of accurate weather analysis and prediction. The quality of weather surveillance and short period forecasting is improving rapidly now that the present series of synchronous meteorological satellites (SMS), launched in May of 1974, has become operational. Two advances in weather monitoring made possible by this satellite are: (1) 24-hour reception of 8 km resolution infrared (IR 10 to 12 μm) cloud pictures at half-hourly intervals, and (2) high resolution (1 km) visual (0.5 to 0.7 μm) pictures every 30 minutes during daylight hours. SMS IR and visible products are currently being used operationally in the following areas: continuous tracking of tropical cyclones and classification of their intensity from their cloud patterns; synoptic and mesoscale analysis of the extratropical cyclone and its associated fronts, jet stream, and smaller scale disturbances; mesoscale analysis and short-range prediction of severe local storms; and mesoscale analysis and short-range prediction of showers, thunderstorms, sea breezes, surface winds, and fog.

36141 (CONF-7510172—P1, pp 173-181) **Remote sensing: potential interference problems and solutions.** Freibaum, J. (National Aeronautics and Space Administration, Washington, DC). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

New remote sensors, especially microwave and high data rate visible and infrared systems, are essential to the development and growth of experimental and operational earth observation satellite applications. High data rate needs impose severe frequency and bandwidth allocation requirements on the spacecraft downlinks whose allocations currently in use are inadequate for future growth of earth observations applications. Similarly, present frequency provisions for microwave sensors are inadequate to meet both current and future needs. Microwave sensor allocation and potential radio interference problems described herein are similar to those of data downlinks; however, only the former is addressed in this paper. Described are needed passive and active microwave allocations for future operations particularly to obtain protection from radio frequency interference, and to ensure that active sensors do not interfere with other users of the frequency spectrum. Some of the potential interference modes, frequency sharing problems and NASA's efforts addressing these problems through its preparations for the 1979 World Administrative Radio Conference (WARC) are discussed. This WARC, the most critical international radio conference since 1959, will consider a general revision of the International Radio Regulations. The outcome of this conference is particularly important to all concerned with expanding the benefits to be obtained through remote sensing by earth observation satellites.

36142 **Time domain accumulation of seismic signals.** Roman, V.I. (Inst. of Ukr. Geophysics, Kiev). *Int. Geol. Rev.;* **18**: No. 9, 1110-1114(Sep 1976).

Translated from Geofiz. Sb.; 58: 20-25(1974).

This entirely theoretical treatment deals with repetitive signals employed for the purpose of reducing the excitation power and still achieving satisfactory depth penetration and resolving power, i.e., the aspect of accumulation of repetitive signals is discussed. A situation is dealt with in which the time intervals between excitation impulses are smaller than the duration of the signal. This results in an interferential-type signal that must be arranged for ultimate stacking. The method is analyzed, with first principles as a goal, by means of information theory and matrix-algebra concepts. The loss of information is estimated and the effectiveness of application of interferential accumulation investigated; a measure of the error of the accumulated signal, due to random noise, is developed, as is a figure of merit that judges the reliability of the error. It is pointed out that this type of signal accumulation appears to be promising for the study of increasingly finer structural features at greater depths.

MINERALOGY, PETROLOGY, AND ROCK MECHANICS

REFER ALSO TO CITATION(S) 35997

36143 (CONF-770440—, pp 804) **Rock mechanics aspects for deep-drilling simulation: formation pore-pressure simulation.** Black, A.D.; Green, S.J.; Wright, G.T. (Terra-Tek, Salt Lake City). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

36144 (CONF-770440—, pp 804) **Empirical relation for dilatant strain in low porosity rock.** Costantino, M.S.; Schock, R.N. (Univ. of California, Livermore). 1977.

From American Nuclear Society topical meeting on energy and mineral recovery research; Golden, CO, USA (12 Apr 1977).

In Energy and mineral resource recovery.

36145 (CONF-7510172—P2, pp 1017-1021) **Study of landslides forecasting by means of thermal transitory of rocks.** Tonelli, A.M. (Istituto per la Geofisica della Litosfera-C.N.R., Milan). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

This paper deals with an "a priori" analysis for studying the thermal behavior of rocky walls during the cooling phase in order to detect possible discontinuities in the mass investigated. The present work compares the digital approach with the analog one, pointing out the working hypothesis to be introduced and the advantages and disadvantages of the different processing systems.

36146 (CONF-7510172—P2, pp 1179-1187) **Computer processing of multispectral observations.** Anthony, S.; Beers, J.N.P.; Blansjaar, P.W.H.; van Kuilenburg, J. (NIWARS, Delft). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

A description of a MSS processing system is given, together with the argumentation which leads to the choice of the specific system design. Field observations of crops are discussed which support the applicability of procedures used. Some output examples are included of LANDSAT-1 imagery obtained over Holland.

36147 **Parameter estimation from non-normal modes of soil-structure interaction.** Beliveau, J.G. (Univ de Sherbrooke, Que). *J. Optimization Theory Appl.;* **23**: No. 1, 41-51(1 Sep 1977).

The damping in soil-structure interaction problems is known to be not proportional; thus, the mode shapes are not normal. Parameters may be estimated, however, including those associated with damping, if use is made of phase angle information. Two examples of this interaction are considered. In the first example, a one-story relatively flexible building, the interaction coefficients are estimated. Soil parameters are identified in a second example of a stiff structure modeling a nuclear reactor containment vessel. Modal information is used in both instances. 9 refs.

GEOCHEMISTRY

REFER ALSO TO CITATION(S) 34542, 34565, 34566, 34567, 35960, 35988, 35997

36148 Hydrogen isotope composition of deep-seated water. Kuroda, Y. (Shinshu Univ., Matsumoto, Japan); Suzouki, T.; Matsuo, S. *Contrib. Mineral. Petrol.;* **60**: No. 3, 311-315(1977).

D/H ratios of phlogopites and amphiboles from rocks of possible mantle origin and also those of water from (glass) inclusions in olivines of the olivine nodule and peridotites were determined. The mantle water seems to have a delta D value of -85 +- 10‰ on the basis of results of inclusions in the nodule-olivine.

36149 Biotite—garnet geothermometer in the region of high temperatures. Shul'diner, V.I. (Far Eastern Geological Inst., Vladivostok, USSR). *Dokl. Akad. Nauk SSSR;* **229**: No. 3, 714-716(21 Jul 1976). (In Russian).

The distribution coefficient of magnesium between garnet and biotite in calcium-depleted, metamorphic ores is determined mainly by the temperature at low and average temperatures. The magnesium distribution coefficient tends to increase with increasing temperature, but this relation tends to vanish at higher temperatures. Here the magnesium distribution coefficient attains a maximum at some temperature, and then begins to decrease with a further rise in temperature. The magnesium distribution coefficient at 500 to 1000°C is given for a number of garnets. 9 refs. (SJR)

OCEANOGRAPHY

36150 (CONF-7510172—P1, pp 39-44) **SEASAT-A: a product of user interests.** McCandless, S.W. Jr. (National Aerospace and Space Administration, Washington, DC). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The SEASAT-A program began with potential users of ocean dynamics data getting together in the spring of 1973 to discuss measurement requirements. Since that time, SEASAT-A has become a new start (FY 75) NASA satellite program dedicated to satisfying these user desires and is scheduled for launch in the second quarter of 1978. It was important to have a working interface between Users and System Designers during the early phases of project definition. These continued dialogs and working integration meetings with Users become even more important, and serve as the key ingredient, in the successful conversion of user requirements into a system which creates user products. This paper describes this process during development of the SEASAT program by showing how user requirements influenced sensor selection, mission planning, satellite systems design, and the end-to-end data system.

36151 Oceanic management: conflicting uses of the Celtic Sea and other western U.K. waters. Sibthorp, M.M. (ed.). London; Europa Publications Limited (1977). 232p. (CONF-7509193—).

From Conference on oceanic management conflicting uses of the Celtic Sea and other western U.K. waters; Swansea, UK (19 Sep 1975).

Ten papers discuss management of coastal waters of the Atlantic Ocean adjacent to United Kingdom. Topics discussed include exploration for natural gas and oil, the fishing industry, the shipping industry, the environmental effects of marine disposal of chemical and radioactive effluents, and national defense of the United Kingdom.

PHYSICS RESEARCH

ASTROPHYSICS AND COSMOLOGY

COSMIC RADIATION

REFER ALSO TO CITATION(S) 35889, 35890

36152 (CONF-740843—P1) **International conference on x-rays in space (cosmic, solar, and auroral x-rays). Volume 1.** (Calgary Univ., Alberta (Canada); National Research Council of Canada, Ottawa, Ontario). Apr 1975. 648p. of Calgary, Alberta, $40.00/set.

From International conference on x-rays in space; Calgary, Canada (14 Aug 1974).

The conference included studies of x-rays of cosmic, solar and auroral origin. Invited talks, contributed papers and panel discussions are included in the proceedings. (GHT)

36153 (LA—7096-MS) **New research initiatives program. Project W-219: chemistry in comet comae. Final report.** Huebner, W.F. (Los Alamos Scientific Lab., N.Mex. (USA)). Feb 1978. Contract W-7405-ENG-36. 9p. Dep. NTIS, PC A02/MF A01.

The scientific objective to investigate theoretically chemical reactions in the comae of comets was accomplished using a one-dimensional model. Ninety-eight species, which involved 441 reactions in the presence of wavelength-dependent solar radiation, were considered in a time-dependent calculation, which includes effects resulting from ultraviolet opacity.

36154 Momentum spectra, charge ratio, and zenith-angle dependence of cosmic-ray muons. Kellogg, R.G.; Kasha, H.; Larsen, R.C. (Physics Department, Yale University, New Haven, Connecticut 06520). *Phys. Rev., D;* **17**: No. 1, 98-113(1 Jan 1978).

A large rotatable magnetic spectrometer was used to measure the sea-level energy spectra of cosmic-ray muons arriving at 30° and 75° zenith angle in the energy range 50—1700 GeV. The measured muon charge ratios and the ratio of the intensities at the two angles imply that the fraction of neutrons in the primary flux at energies above 1 TeV/nucleon is much larger than observed at lower energies and possibly as high as 25 %.

STARS

36155 Thermodynamic inconsistency of the modified Saha equation at high pressures. Sweeney, M.A. (Plasma Theory Division, Sandia Laboratories). *Astrophys. J.;* **220**: No. 1, 335-338(15 Feb 1978).

The inclusion of a pressure ionization term in the Saha equation violates the thermodynamic Maxwell identities if corresponding changes are not made to the expressions for entropy and pressure. It is demonstrated that the usual application of the Rouse and Stewart-Pyatt modesl suffers from this limitation. Negative values of the adiabatic gradient in the degenerate dwarf models of Boehm and Straka are explained in terms of this thermodynamic inconsistency.

36156 Asymptotic freedom and dense stellar matter. II. The equation of state for neutron stars. Kislinger, M.B.; Morley, P.D. (Enrico Fermi Institute and Department of Physics, University of Chicago). *Astrophys. J.;* **219**: No. 3, 1017-1028(1 Feb 1978).

The behavior of the equation of state for cold, dense hadronic matter in asymptotically free gauge theories is examined as nuclear densities are approached from above. By requiring that the energy per baryon be a nucleon mass in the nuclear density regime we determine the on-shell mass for the lightest quarks to be about 355 MeV. We find that hadronic matter is highly incompressible above nuclear densities. Hyperonic matter does not appear at nuclear densities and begins to come in only above 7×10^{14} g cm^{-3}. However, the appearance of hyperonic matter softens the equation of state so that p/rho=0.2 at 10^{15} g cm^{-3}. This softening above 7×10^{14} g cm^{-3} limits neutron star masses from getting exceptionally high, and we find the maximum to be 2.34 M/sub sun/ with central density 10^{15} g cm^{-3} (keeping only the zeroth and first order perturbation contributions to the ground state energy and ignoring the second order which makes only a 10% correction at 6×10^{14} g cm^{-3}) for the currently favored experimental value of the quark fine structure constant. By including the second order, one may go down to about 4×10^{14} g cm^{-3}. Two distinct supernova mechanisms are indicated by our work, one of which occurs in conjuction with black hole formation.

36157 Tidal disruption of stars and the evolution of a massive black hole under the conditions of the galactic center. Dokuchaev, V.I.; Ozernoi, L.M. (Lebedev Physics Institute, USSR Academy of Sciences, Moscow). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 5, 209-211(Sep 1977).

An analysis is given of the growth of a massive black hole which was hypothetically formed at the galactic center 10^{10} yr ago, and has subsequently grown at the expense of stars it has disrupted by its tidal forces and accretion of gas that has been liberated. If the black hole initially was only slightly more massive than 10^2 M/sub sun/, it still would have had time over the past 10^{10} yr to grow to 4×10^6—10^8 M/sub sun/. Since the accretion of gas by so massive a black hole would generate a luminosity far exceeding that observed for the galactic nucleus, the condition M/sub h/9 or $\approx 10^2$ M/sub sun/ may be regarded as an upper limit on the mass of any black hole at the galactic center.

36158 Nature of the radiating particles and the electromagnetic field in the Crab Nebula. Usov, V.V. (Institute for Space Research, USSR Academy of Sciences, Moscow). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 5, 212-214(Sep 1977).

The electromagnetic field within the Crab Nebula is shown to comprise low-frequency waves generated by the spin of the pulsar. The particles responsible for the continuous emission of the nebula are relativistic electrons and positrons ejected from the pulsar. The electron and positron energy spectra should differ by no more than a few percent.

36159 Applicability of the hollow-cone pulsar beam model. Izvekova, V.A.; Malov, I.F.; Malofeev, V.M. (Lebedev Physics Institute, USSR Academy of Sciences, Moscow). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 5, 237-239(Sep 1977).

Hollow-cone beam models are shown to be inconsistent with observational data for pulsars.

36160 Thomson scattering in supernova envelopes and the profiles of the emission lines. Chugai, N.N. (Astronomical Council, USSR Academy of Sciences, Moscow). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 5, 241-243(Sep 1977).

The possibility is examined of detecting an effect due to noncoherent scattering by electrons in the expanding envelope of a supernova. Observational analysis shows that the Hα emission line in the spectrum of supernova 1970g is asymmetrical, probably because of electron scattering. If this is the case, the envelope of supernova 1970g would be fairly homogeneous, with a filling factor of order unity.

36161 Oxygen and carbon abundances in the atmosphere of Arcturus. Kipper, T.A. (Institute of Astrophysics and Atmospheric Physics, Academy of Sciences of the Estonian SSR, Tartu). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 5, 247-248(Sep 1977).

Measured intensities of forbidden oxygen lines and a carbon line in the spectrum of Arcturus together with model-atmosphere calculations yield the abundance estimates log ϵ/sub O/=-3.20 +- 0.10, log ϵ/sub O/=-3.63 +- 0.10.

36162 Excitation of stellar radial pulsation by nonradial modes. Vandakurov, Y.V. (Ioffe Physics and Technology Institute, USSR Academy of Sciences, Leningrad). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 5, 249-251(Sep 1977).

The space-averaged equation of radial motion is considered for a star executing nonradial oscillations. These oscillations may serve as a time-variable external force driving radial pulsations. The process will be most efficient if the nonradial modes include pairs (having the same azimuthal number) with frequencies whose sum or difference is close to the radial-pulsation frequency. In this event radial pulsations will tend to be excited with nearly equal frequencies.

36163 Possible eclipse in the triple system 20 Leonis. Barnes, T.G. III (Univ. of Texas, Austin); Fekel, F.C.; Moffett, T.J. *Publ. Astron. Soc. Pac.;* **89**: No. 531, 658-659(1977).

Observations of a possible eclipse in the 20 Leo system are reported. A discussion of the possible implications on this interesting triple system is also presented.

36164 Strength of the 2.3 μ CO band in weak-G-band stars. Hartoog, M.R. (Univ. of California, Santa Cruz); Persson, S.E.; Aaronson, M. *Publ. Astron. Soc. Pac.;* **89**: No. 531, 660-662(1977).

Broad-band infrared magnitudes and intermediate-band CO indices for 29 weak-G-band stars in the field are presented. The (J - K) color indices of the stars correspond to those of early K giants, in agreement with descriptions of their spectra. All the stars display very weak CO absorption relative to field giants. This confirms a previous conclusion that the weak-G-band stars are deficient in carbon by large factors.

36165 Luminous carbon star in Canis Major OB1. Herbst, W. (Carnegie Institution of Washington, DC); Racine, R.; Richer, H.B. *Publ. Astron. Soc. Pac.;* **89**: No. 531, 663-667(1977).

The fact that W CMa illuminates a reflection nebula is used to argue that it is spatially associated with the CMa OBl/CMa Rl complex. An apparent cluster around the carbon star is found to consist primarily of field stars, although a few probable late B-type members of CMa OBl are identified. On the basis of its likely association with CMa OBl, a luminosity for W CMa is derived. The values M/sub v/ = -4.7 and M/sub bol/ = - 7.2 are found. It seems likely that the progenitor of W CMa was an O-type member of CMa OBl with a mass greater than 20 M/sub solar/ and a main-sequence lifetime less than 3×10^6 years.

36166 Massive hot binary 29 Canis Majoris. Hutchings, J.B. (Herzberg Inst. of Astrophysics, Victoria, B. C.). *Publ. Astron. Soc. Pac.;* **89**: No. 531, 668-674(1977).

The results are presented from analysis of 16 high- and medium-dispersion spectrograms of the system. Mass loss from the primary has a strong dependence on phase in an orbit of low eccentricity. No change in period is detected but the primary star amplitude shows an approximately 10% increase over the value derived from observations in 1957. The secondary spectrum is described and the fundamental parameters of the stars and their evolutionary status are discussed.

36167 Behavior of the Mg II lines near 2800 A in A, B, and O stars. Kondo, Y. (NASA Johnson Space Center, Houston, TX); Morgan, T.H.; Modisette, J.L. *Publ. Astron. Soc. Pac.;* **89**: No. 531, 675-683(1977).

The equivalent widths of the Mg II resonance doublet and their subordinate lines near 2800 A were determined in ten stars of spectral types A through O. Combining the current results with previously published results for four F stars, it is found that the total equivalent widths of the Mg II lines follow a pattern and that the maximum in absorption strength occurs in late-A spectral type. Evidence of mass flow was found in the Algol spectrum together with some other peculiarities. The general behavior of the Mg II lines in stars in this spectral range is also discussed.

36168 Spectroscopic orbit of CC Comae. Rucinski, S.M. (Herzberg Inst. of Astrophysics, Victoria, B. C.); Whelan, J.A.J.; Worden, S.P. *Publ. Astron. Soc. Pac.;* **89**: No. 531, 684-687(1977).

Radial velocity measurements of CC Com, the shortest period W UMa-type system, are presented. The results are combined with photometric results to provide an estimate of the absolute elements. The system has total luminosity 0.29 +- 0.03 L/sub mass/ and masses of 0.69 +- 0.06 M/sub mass/, and 0.36 +- 0.03 M/sub mass/. Formal errors are quoted and the possibility of much larger systematic errors is discussed. The value of the mass ratio derived spectroscopically (0.52 +- 0.03) confirms the value derived from photometry. The distance to CC Com (83 +- 4 pc) is discussed with reference to membership of the Coma cluster (Mel 111). The importance of CC Com for theoretical models of contact binary systems is stressed.

36169 Existence of pairs of carbon stars. Scalo, J.M.; Deeming, T.; Edwards, D.A. (Univ. of Texas, Austin). *Publ. Astron. Soc. Pac.;* **89**: No. 531, 688-692(1977).

The data in Westerlund's (1971) catalog of carbon stars were analyzed in order to determine whether a significant excess of carbon-star pairs exists, as has been previously claimed. A simple and consistent statistical method is presented for comparison of observed and random separation distributions. The differential separation distribution shows no strong evidence for an excess number of pairs, except possibly at very small (approximately $\leqq 0.03^{o}$) separations. The frequency distribution of magnitude differences for different separations and the large implied physical separations suggest that most of these pairs are not physical.

36170 Symmetric velocity structure in the SiO maser spectrum of R Cassiopeiae. Schwartz, P.R. (Hulburt Center for Space Research, Washington, DC). *Publ. Astron. Soc. Pac.;* **89**: No. 531, 693-695(1977).

The SiO J = 1-0, v = 2 lines are exterior to the v = 1 in velocity, strongly suggesting shell-like structure in the emission region.

36171 Photometric study of SW Andromedae. McNamara, D.H.; Feltz, K.A. Jr. (Brigham Young Univ., Provo, UT). *Publ. Astron. Soc. Pac.;* **89**: No. 531, 699-703(1977).

Photometric (uvbyβ) observations of the strong-line RR Lyrae variable SW And are described. The photometry suggests that the star is reddened by E(B-y) = 0./sup m/036. Instrinsic (b-y) and c_1 values are used to derive the variations in T/sub eff/ and log g. The mean values are [T/sub eff] = 6680 K and [log g] = 2.9. Wesselink's method is used to derive a radius R/R/sub mass/ = 4.45. The radius, [T/sub eff/], and [log g] values lead to [M/sub v/] = 0./sup m/9 and M = 0.6 M/sub mass/. Some peculiarities in the behavior of the m_1 index are discussed. The mean m_1 value at light minimum indicates that SW And has a near solar abundance of heavy elements.

36172 Photometry of the FU Orionis stars V1057 cygni and V1515 Cygni. Landolt, A.U. *Publ. Astron. Soc. Pac.;* **89**: No. 531, 704-705(1977).

UBVR photoelectric data were obtained for V1057 Cyg in 1975, 1976, and 1977. Its rate of fading has slowed to 0./sup m/0005 per day. Another FU Ori type object, V1515 Cyg, is found to have photoelectric colors essentially the same as V1057 Cyg.

36173 Intermediate-band photometry of late-type stars III. The Geneva Observatory (GO) photometric system. Eggen, O.J. (Australian National Univ., Canberra). *Publ. Astron. Soc. Pac.;* **89**: No. 531, 706-715(1977).

The Geneva Observatory (GO) photometric system for late-type stars, combined with (R,I) photometry is found to be a useful supplement to results obtained on the modified Stromgren system discussed, previously. Over the range of (R-I) from +0.22/sup M/ to +0.5/sup M/ the values of the metal abundance parameter m_2 in the GO system is related to M_1 similarly ordered $m_2 + 0.60$ and the relation derived can be applied with some accuracy; $[Fe/H] = \alpha M_1 - 2.50$ where $\alpha = 19 - 35(R-I)$. The accuracy of this relation is tested with extensive lists of spectrographic abundance results for G and K stars. Some individual stars, especially metal-rich objects, observed on the GO system are also discussed. The purpose of this investigation was to examine the possibility that observations on the GO system could be used to supplement those on the modified Stromgren system, described in studies of the correlation between metal abundance and kinematics of stars.

36174 Nova-like variable BD-7°3007°. Cowley, A.P. (Dominion Astrophysical Observatory, Victoria, B. C.); Champton, D.; Hesser, J.E. *Publ. Astron. Soc. Pac.;* **89**: No. 531, 716-719(1977).

Simultaneous spectroscopy and rapid photometry show that BD - 7°3007 exhibits significant changes on the time scale of several hours. Radial velocity variations approximately 200 km s^{-1} are seen in the very broad H absorption lines and suggest an orbital period of the system near approximately 0./sup d/25. Very weak variable emission in both H and Ca II appears to arise in an accretion disk about the hot star. No spectroscopic evidence of the secondary is found. Like the other nova-like variables BD - 7°3007 shows flickering and irregular light variation of a few tenths of a magnitude, but it is not known to have suffered any significant outbursts.

QUASI-STELLAR, RADIO, AND X-RAY SOURCES

36175 Radiometer system to map the cosmic background radiation. Gorenstein, M.V.; Muller, R.A.; Smoot, G.F.; Tyson, J.A. (University of California, Lawrence Berkeley Laboratory and Space Sciences Laboratory, Berkeley, California 94720). *Rev. Sci. Instrum.;* **49**: No. 4, 440-448(Apr 1978).

We have developed a 33-GHz airborne radiometer system to map large angular scale variations in the temperature of the 3 K cosmic background radiation. A ferrite circulator switches a room-temperature mixer between two antennas pointing 60° apart in the sky. In 40 min of observing, the radiometer can measure the anisotropy of the microwave background with an accuracy of +- 1 mK rms, or about 1 part in 3000 of 3 K. The apparatus is flown in a U-2 jet to 20 km altitude where 33-GHz thermal microwave emission from the atmosphere is at a low level. A second radiometer, tuned to 54 GHz near oxygen emission lines, monitors spurious signals from residual atmospheric radiation. The antennas, which have an extremely low side-lobe response of less than -65 dB past 60°, reject anisotropic radiation from the earth's surface. Periodic interchange of the antenna positions and reversal of the aircraft's flight direction cancel equipment-based imbalances. The system has been operated successfully in U-2 aircraft flown from NASA-Ames at Moffett Field, CA.

36176 Was the bright transient x-ray source Centaurus XR-4 I a globular cluster. Seward, F.D. (Univ. of California, Livermore); Liller, W. *Publ. Astron. Soc. Pac.;* **89**: No. 531, 696-698(1977).

The globular cluster NGC 5824 lies within the error box of the transient x-ray source Cen XR-4. The characteristics of the cluster make it a likely candidate for a globular cluster x-ray source. Observations of the transient x-ray source and the characteristics of the globular cluster are briefly reviewed. If the source originated in the globular cluster, the maximum x-ray luminosity was 3 x 10^{40} erg sec^{-1}, two orders of magnitude more luminous than any other observed galactic or globular cluster x-ray source. The implication of this result is that a massive black hole might exist within the cluster.

36177 UBV observations of CD-33°12119. Bord, D.J. (Benedictine Coll., Atchison, KS); Mook, D.E.; Petro, L.; Thomas, J.; Hiltner, W.A. *Publ. Astron. Soc. Pac.;* **89**: No. 531, 720-723(1977).

The star CD -33°12119, a suggested optical counterpart of x-ray source 3U 1727-33, was studied photometrically. Brightness and color variations are observed on a time scale of days, but no regular pattern to these fluctuations is evident. Evidence for flares in U and B is discussed.

36178 Ne II 12.8μ emission from the galactic center and compact H II regions. Wollman, E.R. Berkeley, CA; Univ. of California (1976). 98p. University Microfilms Order No. 77-15,915.

Thesis (Ph. D.).

The Ne II 12.8μ fine-structure line has been observed in emission from the galactic center and several compact H II regions.

SOLAR PHENOMENA

REFER ALSO TO CITATION(S) 36152

36179 Nature of the quasiperiodic magnetic-field and velocity oscillations in a sunspot. Shel'ting, B.D. (Institute of Terrestrial Magnetism, the Ionosphere, and Radio Wave Propagation, USSR, Academy of Sciences, Moscow Oblast'). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 5, 222-225(Sep 1977).

The model of trapped oscillations in a resonance cavity is considered for selected values of the parameters describing the atmosphere of a sunspot. The wave equation of magnetohydrodynamics is solved both analytically with constant parameters and numerically with allowance for the height dependence of the scale height. These solutions yield series of resonance periods in good accord with the values observed.

36180 Nonlinear alfven waves in high speed solar wind streams. Abraham-Shrauner, B.; Feldman, W.C. (Los Alamos Scientific Lab., NM). *J. Geophys. Res.;* **82**: No. 4, 618-624(1 Feb 1977).

A nonlinear proton distribution function that is an exact stationary solution of the nonlinear Vlasov equation and Maxwell's equations and which supports a single nonlinear transverse Alfven (ion cyclotron) wave that is circularly polarized and nondispersive is proposed for most of the observations during high speed solar wind streams. This nonlinear distribution removes the strong Alfven wave instability, inconsistent with the persistence of the observed proton distribution functions in high speed streams, found by the linear stability analysis. Model temperature anisotropies and drift velocities of the two spatially inhomogeneous bi-Maxwellian components are consistent with typical proton velocity distributions measured in high speed streams at 1 AU. Two derived relations for each of the wave number and the phase velocity of the wave are obeyed within experimental uncertainties by two typical proton measurements. The model also predicts that the alpha particle bulk flow velocity exceeds the proton particle bulk flow velocity, as is observed.

GALAXIES

36181 Submillimeter observations of the galactic center. Hildebrand, R.H.; Whitcomb, S.E.; Winston, R.; Stiening, R.F.; Harper, D.A.; Moseley, S.H. (Enrico Fermi Institute and Department of Physics, University of Chicago). *Astrophys. J., Lett.;* **219**: No. 3, L101-L104(1 Feb 1978).

We have mapped a 15' +- 15' region surrounding Sgr A at a mean wavelength of 540 μm. The principal feature is a ridge about 10'long running parallel to the galactic equator and approximately centered on Sgr A but with no peak at the point. The ridge coincides with the 25 and 55 km s^{-1} clouds seen in molecular line observations. We estimate the mass of the clouds and discuss their positions with respect to the galactic center.

36182 Rotation of Wolf—Rayet stars and the ellipticity of the nebulae surrounding them. Avedisova, V.S. (Astronomical Council, USSR Academy of Sciences, Moscow). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 5, 217-219(Sep 1977).

An analysis is made of the proposal that the ellipticity observed in the nebulae surrounding certain Wolf—Rayet stars results from differences in the intensity of the mass outflow from the poles of the star and from the equator, as caused by rotation of the star. Two models are considered: 1) rotation of the stellar core at critical velocity, with the nebula formed from interstellar matter through the action of stellar wind; 2) slow rotation of a giant star, with ejection of an envelope into the interstellar medium.

36183 Scattering and scintillation of the radiation from the galactic center as indicators of its nature. Ozernoi, L.M.; Shishov, V.I. (Lebedev Physics Institute, USSR Academy of Sciences, Moscow). *Sov. Astron. Lett. (Engl. Transl.);* **3**: No. 5, 233-235(Sep 1977).

Recent radio interferometer measurements of the size and structure of the pointlike radio source at the galactic center suggest that the scattering of radiation by electron density irregularities plays an important role. The scatter region is probably located in the vicinity of the radio source. The turbulence parameters in this region are estimated. Several experiments are proposed to ascertain the character of the turbulence more accurately and to clarify the nature of the point source.

ATMOSPHERIC PHYSICS

36184 (LBL—6016, pp 235-240) **Radiation and separation research.** 1976.

In Materials and Molecular Research Division annual report, 1976.

Radiation and separation research activities in molecular sciences at Lawrence Berkeley Laboratory during 1976 are described. Emphasis is on photochemistry of materials in the stratosphere. (GHT)

AURORAL AND IONOSPHERIC PHENOMENA

REFER ALSO TO CITATION(S) 36152

36185 Vibrational populations of the excited states of N_2 under auroral conditions. Cartwright, D.C. (Theoretical Division, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Geophys. Res.;* **83**: No. A2, 517-531(1 Feb 1978).

The equations of statistical equilibrium for the population and depopulation of the electronic states of N_2 have been solved for steady state normal auroral conditions. All vibrational levels for the seven lowest triplet electronic states (A, B, W, B', C E, D) and the three lowest excited singlet electronic states (a, a', w) of N_2 were included in the calculations. Recently mesured auroral secondary

electron spectra were employed to calculate the rates for electron impact excitation. The transition probabilities, electron impact excitation cross sections, and vibrationally dependent quenching rates used were a combination of the best available experiment and theoretical data. The results of these calculations are the absolute vibrational populations of all the electronic states. Intrasystem cascading and vibrationally dependent quenching were found to be important in determining the vibrational populations in the lower singlet and triplet excited electronic states. The predicted vibrational populations for the A and B triplet states agree well with the available experiment data. These calculations predict that a fairly large density of N_2 in excited metastable states in produced under auroral conditions.

36186 Auroal electron distribution function. Kaufmann, R.L.; Dusenbery, P.B.; Thomas, B.J.; Arnoldy, R.L. (Department of Physics, University of New Hampshire, Durham, New Hampshire 03824). *J. Geophys. Res.;* **83**: No. A2, 586-598(1 Feb 1978).

The electron velocity distribution function is presented in the energy range 25 eV $<E<$15 keV during a rocket flight over an active aurora. The electron measurements are compared with optical observations by all-sky cameras and a television system. The most striking feature of the velocity distribution function is a broad plateau produced by downcoming electrons. This plateau is the feature of the electron distribution function that is associated with discrete auroral forms. Plateaus either appear or broaden by extending to higher energies each time a bright form is entered. The plateaus decay by erosion of the highest-velocity portions when the rocket passes either out of an arc or into weak diffuse auroral structures. The high-velocity cutoff of the plateau also fluctuates when small field-aligned rays appear within the arcs. Kilovolt electrons were field aligned during portions of this flight, though such alignment was not as striking as that on previous flights. The field alignment is usually confined to a narrow energy band but extends over a broad range of energies during one interval. Electrons with $v<10 \times 10^8$ cm/s (E=300 eV) are nearly isotropic in pitch angle throughout the flight. Upgoing electrons show almost no pitch angle dependence beyond 120^0, and their fluxes decline smoothly as energy increases, with little or no evidence of a plateau. Preliminary results of numerical integrations, to study bulk properties and stability of the plasma are presented.

MAGNETOSPHERIC PHENOMENA

36187 Multiple-satellite studies of magnetospheric substorms: Distinction between polar magnetic substorms and convection-driven negative bays. Pytte, T.; McPherron, R.L.; Hones, E.W. Jr.; West, H.I. Jr. (Institute of Geophysics and Planetary Physics, University of California, Los Angeles, California 90024). *J. Geophys. Res.;* **83**: No. A2, 663-679(1 Feb 1978).

It is generally believed that long intervals of intense (500-1000 γ) negative auroral zone bays are caused by magnetospheric substorm occurrences at a high repetition rate. Since individual substorm phases may then overlap in time and occur within limited local time sectors, it may be difficult to identify their characteristic signatures. In this paper we have examined ground and multiple-satellite recordings during an ~5-hour interval of persistent auroral zone activity in a systematic search for substorm expansion signatures. It appears that this enduring activity started as a rather weak substorm which thereafter developed into strong magnetospheric activity driven by a continuously southward interplanetary magnetic field (IMF). During this period there were no clear mid-latitude positive bays, and pulsation recordings from different local time sectors showed only one instance of weak Pi 2-like variations. The associated high-latitude equivalent ionospheric current pattern is consistent with a convection system, and we refer to this activity as the convection bay. Following the plasma sheet and ground signatures of substorm recovery early in the convection bay, there was no definite indication of substorm expansions other than this weak magnetic pulsation in any recordings during the next ~3-1/2 hours until a clear substorm emerged. This substorm onset, which was associated with a not particularly strong auroral zone bay, was accompanied by the full complement of substorm expansion signatures. At this time a minimum plasma sheet thickness of only a few tenths of an earth radius was observed in the region where a neutral line appears to form during substorms. Prior to this onset, the plasma sheet was relatively thick, and it seems that the neutral line was located well tailward of the Vela orbit (r~18 R/sub E/).

36188 Stimulated growth of coherent VLF waves in the magnetosphere. Stiles, G.S. (Los Alamos Scientific Lab., NM); Helliwell, R.A. *J. Geophys. Res.;* **82**: No. 4, 523-530(1 Feb 1977).

The amplitude behavior of several hundred VLF whistler mode pulse signals and of their associated artificially stimulated emissions (ASE's) was analyzed with digital signal processing techniques. A survey of the results indicates that the pulse signals characteristically show exponential growth with time that is highly repeatable over short periods. However, the growth rate varies widely from time to time, covering a range of 25 to 250 dB/s. During the exponential growth phase of the pulse there is no observable change in frequency. Emissions may begin when growth stops or when the input pulse terminates, whichever occurs first. Low growth rates and falling emissions characterize the beginning and ending of extended periods of emission activity. Rising emissions are prominent at the height of activity. ASE's triggered by station NAA (14.7 kHz, 1 MW radiated) begin when the transmitted Morse dash terminates (dash length, 150 ms). Some ASE's triggered by pulses from Siple Station, Antarctica (1.6 to 7 kHz, < or = to 1 kW), and Omega, New York (10.2 kHz, 100 W), show similar behavior; others, however, begin prior to the termination of the triggering pulse when the pulse length exceeds 200 ms. Growth and frequency change of the ASE tend to be independent of one another. For transmitted pulses of sufficient duration the amplitude saturates prior to termination. Signal amplitudes may reach 30 dB or more above the initial level. During growth the measured bandwidth of the signal remains near the minimum possible (approximately 27 Hz) with the given analysis resolution (approximately 30 ms, approximately 50 Hz). By comparison with mathematical models it is shown that the observed signals have the maximum possible coherence for the measured values of growth rate and duration. These observations are in qualitative agreement with a model that attributes signal growth and ASE's to an interaction between coherent waves and counterstreaming gyroresonant electrons.

ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS

REFER ALSO TO CITATION(S) 35541, 36337

36189 Ab initio effective core potentials for molecular calculations. II. All-electron comparisons and modifications of the procedure. Hay, P.J.; Wadt, W.R.; Kahn, L.R. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *J. Chem. Phys.;* **68**: No. 7, 3059-3066(1 Apr 1978).

Recently methods have been developed [L. R. Kahn, P. Baybutt, and D. G. Truhlar, J. Chem. Phys. 65, 3826 (1976)] to replace the core electrons of atoms by ab initio effective core potentials (ECP). Valence-electron calculations are reported on the ground states of HF, F_2, HCl, LiCl, and Cl_2 using ECP's for F and Cl, and the results are compared to all-electron calculations. Significant discrepancies are found (as much as 20 kcal/mol for D/sub e/ and 0.3 bohr for R/sub e/ in the case of Cl_2) between the two sets of calculations. The original formulation of generating ECP's can lead to artificial attractive tails in the potential at large values of r which leads to potential energy curves which are too attractive. The procedure of generating ECP's is modified to remove the long-range attractive tails. Excellent agreement between the valence-electron and all-electron calculations is then obtained.

BEAMS AND THEIR REACTIONS

REFER ALSO TO CITATION(S) 36206

36190 (LBL—6016, pp 306-354) **Photoelectron spectroscopy.** Shirley, D.A. 1976.

In Materials and Molecular Research Division annual report, 1976.

Research activities in photoelectron spectroscopy at Lawrence Radiation Laboratory during 1976 are described. Topics covered include: the orientation of CO on Pt(III) and Ni(III) surfaces from angle-resolved photoemission; photoemission from CO on Pt(III) in the range 40 eV less than or equal to dirac constant ω less than or equal to 150 eV; photoemission studies of electron states at clean surfaces using synchrotron radiation; angle and energy dependent photoemission studies of plasmon loss structure in Al and In; d-orbital directed photoemission from copper; interpretation of angle-resolved x-ray photoemission from valence bands; atomic cross-section effects in soft x-ray photoemission from Ag, Au, and Pt valence bands; x-ray photoelectron spectroscopic studies of the electronic structure of transition metal difluorides; x-ray photoemission investigation of the density of states of B'-NiAl; the electronic structure of $SrTiO_3$ and some simple related oxides; fluorescence lifetime measurements of $np^5(n+1)S'$ states in krypton and xenon; Zeeman beats in the resonance fluorescence of the $3P_1$, states in krypton and xenon; lifetime measurements of rare-gas dimers; configuration interaction effects in the atomic photoelectron spectra of Ba, Sm, Eu, and Yb; glow discharge lamps as electron sources for electron impact excitation; electron impact excitation of electron correlation states in Ca, Sr, and Ba; photoelectron spectroscopy of atomic and molecular bismuth; relativistic effects in the uv photoelectron spectra of group VI diatomic molecules; and relative gas-phase acidities and basicities from a proton potential model. (GHT)

36191 (UCID—17647) **Optical emissions from an ionized channel produced by an electron beam.** Fessenden, T.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 21 Nov 1977. Contract W-7405-ENG-48. 24p. Dep. NTIS, PC A02/MF A01.

Quantitative measurements of the visible light generated by the Astron beam (5 MeV, 400 A) in passing through 500 torr air and nitrogen are reported. Experiments show that in the presence of the beam, the light is from .01 to 0.1 percent sun's brightness. After the beam, the light decays extremely rapidly. The size and position of the beam in the gas can be determined from observations of the channel light.

36192 **Work-function dependence of negative-ion production during sputtering.** Yu, M.L. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev. Lett.;* **40**: No. 9, 574-577(27 Feb 1978).

A systematic study was made to negative-ion formation by sputtering from a Mo(100) surface with and without adsorbate layers. Correlation with the work-function change when the surface electronic state was modified by a Cs overlayer reveals a possible tunneling mechanism. Tunnel barrier widths and heights were estimated for Mo^-, O^-, H^-, and D^- from the experimental data.

ATOMIC AND MOLECULAR PROPERTIES

REFER ALSO TO CITATION(S) 36210

36193 (IAEA—199, pp 541-587) **Time for atomic and molecular data bases is now. An overview of data management research at LLL.** Hampel, V.E.; Henry, E.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1977.

From Advisory group meeting on atomic and molecular data for fusion; Abingdon, Oxfordshire, UK (1 Nov 1976).

Preprint UCRL-79286.

In Atomic and molecular data for fusion.

We have created two numerical data bases of atomic and molecular (A+M) data required for laser induced fusion studies. One file contains primarily atomic energy levels and atomic transition data released by Charlotte E. Moore in NBS publications. The second file is based on the spectroscopic constants for more than 1000 molecular levels of approximately 160 heteronuclear diatomic molecules prepared by S. N. Suchard. Additional data bases are contemplated in support of the accelerating research activities in these fields. The present paucity of authenticated, computer-readable A+M data is not unlike that observed two decades ago in nuclear fission research. At that time, emphasis was also given to the accurate measurement of physical parameters and to reaction rates which eventually led to the ENDF/B series of evaluated neutron cross sections. Today, powerful computers have a more dominant role in modeling and predicting the results of promising experiments. Their effective use, however, depends more than ever before upon the availability of comprehensive and accurate files of A+M data. At the Lawrence Livermore Laboratory (LLL), these requirements are accentuated by the heavy reliance on computers. Also, trends are presently becoming apparent among users of the national computer network for Magnetic Fusion Energy (MFE), with its center at LLL, to coalesce organization-dependent data files into central data bases containing bibliographic information and numerical data as a common resource. The Data Management Research Project (LLL/DMRP) is collaborating with the National Bureau of Standards (NBS/NSRDS) to be able to respond to the emerging requirements. This should contribute to a "Public Well" of atomic and molecular data, unencumbered by legal or monetary constraints.

36194 (IAEA—199, pp 491-508) **Computer storage, retrieval and generation of atomic data.** Smith, F.J. (Queen's Univ., Belfast, Northern Ireland (UK)). 1977.

From Advisory group meeting on atomic and molecular data for fusion; Abingdon, Oxfordshire, UK (1 Nov 1976).

In Atomic and molecular data for fusion.

A system has been built at Belfast for the storage, manipulation and retrieval of critical data related to atomic interactions. Included in the data bank are over 2000 interaction potentials which can be retrieved with their reference data in whatever form or units are required by the user. A least square curve fit to the stored data can also be obtained with the correct asymptotic limits in the form of a table, a graph plot sent in the post next morning, as a pseudo-plot on a terminal or as a FORTRAN subroutine which can generate the data. If the data required is not available the system may be able to compute approximate values from other data in the system since relations between sets of data as well as the data itself are stored. For example, from the interaction potentials one can obtain deflection angles, phase shifts, differential and total cross sections and shortly also exchange cross sections, transport properties, virial coefficients, etc., at any energy or temperature for which some data is available.

36195 (LBL—6016, pp 379-384) **Atomic physics.** 1976.

In Materials and Molecular Research Division annual report, 1976.

Research activities in atomic physics at Lawrence Berkeley Laboratory during 1976 are described. Topics covered include: experiments on stored ions; test for parity violation in neutral weak currents; energy conservation and astrophysics; atomic absorption spectroscopy, atomic and molecular detectors; theoretical studies of quantum electrodynamics and high-z ions; atomic beam magnetic resonance; radiative decay from the 2^3Po_2 levels of helium-like argon; quenching of the metastable 2S/sub 1/2/ state of hydrogen-like argon in an external electric field; and lifetime of the 2^3Po level of helium-like krypton.

36196 (LBL—7344) **Vibrational relaxation and energy transfer of matrix isolated HCl and DCl.** Wiesenfeld, J.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Dec 1977. Contract W-7405-ENG-48. 386p. Dep. NTIS, PC A17/MF A01.

Thesis.

Vibrational kinetic and spectroscopic studies have been performed on matrix-isolated HCl and DCl between 9 and 20 K. Vibrational relaxation rates for $v = 2$ and $v = 1$ were measured by a tunable infrared laser-induced, time-resolved fluorescence technique. In an Ar matrix, vibrational decay times are faster than radiative and it is found that HCl relaxes about 35 times more rapidly than CCl, in spite of the fact that HCl must transfer more energy to the lattice than DCl. This result is explained by postulating that the rate-determining step for vibrational relaxation produces a highly rotationally excited guest in a V yield R step; rotational relaxation into lattice phonons follows rapidly. HCl $v = 1$, but not $v = 2$, excitation rapidly diffuses through the sample by a resonant dipole-dipole vibrational energy transfer process. Molecular complexes, and in particular the HCl dimer, relax too rapidly for direct observation, less than or approximately 1 μs, and act as energy sinks in the energy diffusion process. The temperature dependence for all these processes is weak—less than a factor of two between 9 and 20 K. Vibrational relaxation of HCl in N_2 and O_2 matrices is unobservable, presumably due to rapid V yield V transfer to the host. A V yield R binary collision model for relaxation in solids is successful in explaining the HCl(DCl)/Ar results as well as results of other experimenters. The model considers relaxation to be the result of "collisions" due to molecular motion in quantized lattice normal modes—gas phase potential parameters can fit the matrix kinetic data.

36197 (SAND—78-8200) **Real gas equation-of-state capability at Sandia Livermore.** Clark, G.L. (Sandia Labs., Livermore, Calif. (USA)). Mar 1978. Contract EY-76-C-04-0789. 344p. Dep. NTIS, MF A01.

Portions of document are illegible.

A library of FORTRAN routines is described which model the equations-of-state for gases commonly encountered in compressible gas dynamics applications. The present library includes thermodynamic properties packages as well as compressibility models, both for pure gases and mixtures. Tables are included to allow hand calculation of equation-of-state problems for the gases hydrogen, helium, neon, argon, oxygen, air, and nitrogen. Generally the tables extend to several thousand atmospheres, with temperatures from the cryogenic realm to 400 K.

36198 **High-resolution cw stimulated Raman spectroscopy in molecular hydrogen.** Owyoung, A. (Sandia Laboratories, Albuquerque, New Mexico 87115). *Opt. Lett.;* **2**: No. 4, 91-93(Apr 1978).

We report the application of low-power cw laser sources in obtaining high-resolution stimulated Raman spectra (SRS) of the Q_{01} (1) transition in molecular hydrogen. Fully resolved spectra of both the real and the imaginary parts of the Raman susceptibility, obtained with a resolution of <25 MHz, show a motionally narrowed minimum linewidth of 250 +- 5 MHz. The cw SRS techniques reported herein should find a variety of applications in high-resolution Raman studies.

36199 **High-J assignments in the 10.5-μm SF_6 spectrum: identification of the levels pumped by CO_2 P (12) and P (22).** McDowell, R.S.; Galbraith, H.W.; Cantrell, C.D.; Nereson, N.G.; Moulton, P.F.; Hinkley, E.D. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Opt. Lett.;* **2**: No. 4, 97-99(Apr 1978).

Quantum numbers (J values and octahedral symmetry types) of the SF_6 transitions from the vibrational ground state to $v_3 = 1$ that fall near the CO_2 P (12) and P (22) laser lines have been assigned. The significance of these assignments for the results of self-induced transparency and photon-echo experiments is discussed briefly.

36200 **Adiabatic correction for nonlinear triatomic molecules: Techniques and calculations.** Bardo, R.D.; Wolfsberg, M. (Department of Chemistry, University of California, Irvine, California 92717). *J. Chem. Phys.;* **68**: No. 6, 2686-2695(15 Mar 1978).

In the Born-Oppenheimer (BO) approximation the isotopic-mass-independent BO electronic energy is the potential energy surface for nuclear motion. The first correction to the BO approxima-

tion is obtained by adding the isotopic-mass-dependent adiabatic correction C to this potential energy surface. The adiabatic correction for a nonlinear triatomic molecule in a nondegenerate electronic state is expressed in terms of one-electron integrals over atomic basis functions. Both single determinant molecular orbital BO electronic wavefunctions and configuration interaction wavefunctions are discussed. The adiabatic correction is calculated for H_2O and H^+_3 and their isotopic variants at the respective equilibrium internuclear geometries. Theses adiabatic corrections are combined with those previously calculated for diatomic molecules to obtain correction factors to equilibrium constants for H/D isotopic exchange reactions calculated within the framework of the BO approximation.

36201 **Equation of state of molecular hydrogen at high pressure.** Liberman, D.A. (Los Alamos Scientific Lab., NM). *Int. J. Quant. Chem., Symp.;* No. 10, 297-303(1976).

An equation of state for solid molecular hydrogen at 0°K is obtained using the self-consistent-field method for calculating the electronic structure of the solid. Pressures up to 12.5 megabars are included in the calculation. Errors in the pressure are less than 5 kilobars in the low-pressure region where experimental data are available. It is hoped that they are less significant at higher pressures.

POSITRONIUM, MUONIUM, AND MUONIC AND MESIC ATOMS AND MOLECULES

36202 **Higher-order corrections to level energies of muonic atoms.** Rinker, G.A.; Steffen, R.M. (Institut fuer Kernphysik der Kernforschungsanlage JuelichD-5170, Juelich, West Germany). *At. Data Nucl. Data Tables;* **20**: No. 2, 143-159(Aug 1977).

In order to facilitate the analysis of muonic-atom x-ray spectra, the results of numerical computations of presently important higher-order corrections to the energy-level values of muonic atoms are presented in tabular form. These include various types of vacuum-polarization, self-energy, electron-screening, and recoil (relativistic nuclear motion) corrections. All calculations were made with a two-parameter Fermi distribution of the nuclear charge density.

COLLISION PHENOMENA

REFER ALSO TO CITATION(S) 36191

36203 (COO—2793-11) **Information theoretic analysis of multiphoton excitation and collisional deactivation in polyatomic molecules.** Jensen, C.C.; Steinfld, J.I.; Levine, R.D. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Chemistry). 1978. Contract EY-76-S-02-2793. 37p. (CONF-780510—1). Dep. NTIS, PC A03/MF A01.

From 10. quantum electronics conference; Atlanta, GA, USA (May 1978).

The procedure of maximal entropy is applied to characterize the three distributions over energy states which are of direct interest for studies of multiple photon excitation of polyatomic molecules. These distributions are the original population of the different energy states given the mean number of photons absorbed, the distribution over the final energy states after a single collision, given a well defined initial energy state and the mean energy transfer per collision, and the time evolution of the population of the different energy states due to collisional deactivation, given the mean energy transfer per collision. Good agreement with experimentally determined values of (ΔE), the average amount of energy removed in a collision, are obtained for deactivation of sec-butyl, cyclohexane, β-hexyl, and β-naphthylamine by structureless collision partners such as He or H_2. The vibrational relaxation surprisal parameter is found to be lambda$_1$ approximately equal to 0.1 for all these systems. This is much closer to a statistical, or strong-collision limit, than vibrational deactivation of diatomics by atoms, for which lambda$_1$ is approximately equal to 1.0. Deactivation most likely proceeds through a sequence of maximal-entropy distributions.

36204 (COO—4199-1) **Experimental studies of electron impact depopulation of excited states of atoms: application to laser development for fusion and isotope separation. Progress report, January 1, 1977—December 31, 1977.** Lubell, M.S. (Yale Univ., New Haven, Conn. (USA)). 1 Mar 1978. Contract ES-77-S-02-4199. 12p. Dep. NTIS, PC A02/MF A01.

Research on the depopulation of metastable states of rare gas atoms by electron impact is summarized. Superelastic, inelastic, and ionization processes are studied using a crossed electron-atom beams configuration. 17 references. (JFP)

36205 (LBL—6016, pp 295-298) **Chemical dynamics studies.** Mahan, B.H. 1976.

In Materials and Molecular Research Division annual report, 1976.

Research activities at Lawrence Berkeley Laboratory in chemical dynamic studies during 1976 are described. Topics covered include: sequential impulse model of direct reactions; high energy reactive scattering of N^+ by H_2*; low energy reactive scattering of N^+ by H_2*; a low egergy ion-molecular beam apparatus; dynamics of the F^+-H_2 reaction; and laser induced fluorescence of gaseous ions. (GHT)

36206 (LBL—6016, pp 299-305) **Theory of low energy atomic and molecular collisions.** Miller, W.H. 1976.

In Materials and Molecular Research Division annual report, 1976.

Research activities into theory of low energy atomic and molecular collisions at Lawrence Berkeley Laboratory during 1976 are described. Topics covered include: semiclassical theory for eigenvalues and reaction rate constants of non-separable systems; unified statistical model for "complex" and "direct" reaction mechanisms; semiclassical eigenvalues for irregular spectra; atomic scattering from a sinusoidal hardwall surface; and Penning ionization of H_2 by He*(2^3S). (GHT)

36207 (LBL—6016, pp 355-371) **Crossed molecular beams.** Lee, Y.T. 1976.

In Materials and Molecular Research Division annual report, 1976.

Research activities with crossed molecular beams at Lawrence Berkeley Laboratory during 1976 are described. Topics covered include: scattering of Ar*, Kr*, with Xe; metastable rare gas interactions, He* + H_2; an atomic and molecular halogen beam source; a crossed molecular beam study of the Cl + Br_2 → BrCl + Br reaction; O(^{3}P) reaction dynamics, development of the high pressure plasma beam source; energy randomization in the Cl + C_2H_3Br → Br + C_2H_3Cl reaction; high resolution photoionization studies of NO and ICl; photoionization of (H_2O)/sub n/ and $(NH_3)_2$; photoionization mass spectroscopy of NH_3^+ and O_3^+; photo fragmentation of bromine; and construction of chemiluminescence-laser fluorescence crossed molecular beam machine. (GHT)

36208 (UCRL—80521) **Chemiluminescence from the reaction of Ba ^{3}D with nitric oxide.** Johnson, S.A.; Solarz, R.W.; Dubrin, J.W.; Brotzmann, R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 5 Jan 1977. Contract W-7405-ENG-48. 4p. (CONF-780510—2). Dep. NTIS, PC A02/MF A01.

From 10. quantum electronics conference; Atlanta, GA, USA (May 1978).

The reaction of laser excited Ba*(^{3}D) states with nitric oxide is presented. BaO product is not detected, although the channel is thermodynamically open, and instead chemiluminescence is observed. Experiments which suggest that radiative recombination, Ba + NO → BaNO* → BaNO, is the observed reaction channel will also be presented.

36209 **Low energy ionizing collisions between N_2 and CO beam molecules and CO, N_2, NO, CH_4, and CO_2 target molecules.** Utterback, N.G.; Van Zyl, B. (TRW, Inc., Redondo Beach, California 90278). *J. Chem. Phys.;* **68**: No. 6, 2742-2752(15 Mar 1978).

Absolute total negative charge production cross sections for N_2+CO, CO+N_2, CO+CO, N_2+NO, N_2+ CH_4, and N_2+CO_2 collisions have been measured to within about 1 eV of their respective thresholds. Mass spectrometric identification of the product ions scattered in the forward direction has been used to investigate specific reaction channels and explain characteristic structures in the total charge production cross sections in the near-threshold regions. Such structures, the most dramatic of which results from the N_2+CO →NO^+ +CN^- ion pair formation reaction, tend to dominate the cross section shapes at low energies. Dissociative ionization is also shown to be important in such collisions. In fact, "simple" ionization, where one of the initial molecules simply gives up an electron, is not even an important process for some reactants in this low energy regime. The results of the cross section measurements and the mass spectrometric investigations are presented and a simple model of the collision to aid in understanding the results is discussed. Also presented are charge transfer cross sections for CO^+ +CO, CO^+ +CH_4, and N^+_2+CH_4 and secondary electron emission coefficients for CO molecules on a gold surface.

36210 **Autoionization structure of nitric oxide (NO) at the first ionization limit.** Miescher, E.; Lee, Y.T.; Guertler, P. (Institute of Physics, University of Basel, Basel, Switzerland). *J. Chem. Phys.;* **68**: No. 6, 2753-2756(15 Mar 1978).

A new and more detailed interpretation is given to the fine structure in the photoionization curve of cold NO observed by Ng, Mahan, and Lee. Resonances are assigned to autoionizing np and ndδ Rydberg levels which give prominent diffuse absorption bands in a spectrum recorded with the synchrotron radiation continuum. Δv<-1transitions in the vibrational autoionization process are substantiated.

36211 **Charge transfer reactions of ground C^+(^{2}P) and excited C^+(^{4}P) state ions with neutral molecules.** Moran, T.F.; Wilcox, J.B.

(School of Chemistry, Georgia Institute of Technology, Atlanta, Georgia 30332). *J. Chem. Phys.;* **68**: No. 6, 2855-2860(15 Mar 1978).

Total charge transfer cross sections have been measured for the reactions of 0.7-2.5 keV C^+ (^2P) and C^+ (^4P) ions with Ar, H_2, N_2, CO, CO_2, and O_2. Time-of-flight techniques have been used to measure the fast neutral C^0 products from charge transfer reactions. These reactions have been examined as a function of the electron energy used to produce the reactant ions and reaction cross sections determined for ground C^+ (^2P) and excited C^+ (^4P) state ions. Reactant C^+ beams have been produced by controlled electron impact ionization of carbon monoxide. The cross sections for charge transfer reactions involving the excited C^+ (^4P) ions are significantly larger than the corresponding reactions of ground state ions.

36212 Effects of "post-collision interactions" on near-threshold measurements of autoionizing states in Ne from scattered electron spectra. Spence, D. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* **68**: No. 6, 2980-2981(15 Mar 1978).

The autoionizing states in Ne have been studied by measuring the yield of scattered sections of chosen fixed final enegies between 20 ev and 3 ev in steps of 0.01 eV. (AIP)

36213 Fixed-molecule photoelectron angular distributions: K-shell cross sections of CO at fixed detection angles. Wallace, S.; Dill, D.; Dehmer, J.L. (Department of Chemistry, Boston University, Boston, Massachusetts 02215). *Phys. Rev., B;* **17**: No. 4, 2004-2010(15 Feb 1978).

Photoelectron angular distributions, doubly differential in target and detector orientation, are calculated for K-shell ionization of carbon and oxygen in CO at the f-wave shape resonance in the σ ($\lambda = 0$) channel (0.8-Ry kinetic energy). Dipole amplitudes are computed by the multiple-scattering formulation of inner-shell photoionization. Results are presented for several fixed-detector orientations and all possible target orientations for linearly, circularly, and naturally polarized light. Distributions are rich in structure because of the interplay of anisotropies in target and detector orientations, and serve to predict the complexity of measured distributions.

36214 Pseudostates and low-energy electron-molecule collisions: applications to H_2 and N_2. Schneider, B.I. (Los Alamos Scientific Lab., N.Mex. (USA)). *Chem. Phys. Lett.;* **51**: No. 3, 578-581(1 Nov 1977).

A simple procedure for generating pseudostates for low-energy electron-molecule collisions is described which requires only a standard Hartree-Fock program. The technique uses an additional nuclear center to simulate the distortions of the charge cloud of the molecule by a low-energy electron. Calculations are presented for H_2 and N_2 which show that accurate pseudo-orbitals can be obtained by the method. A simple application of the pseudo-state orbitals for low-energy e + H_2 scattering gives results which are in very good accord with experiment and represents the first ab initio treatment of both electron exchange and polarization in an electron-molecule collision.

36215 Bremsstrahlung energy spectra from electrons of kinetic energy 1 keV< or =T_1< or =2000 keV incident on neutral atoms 2< or =Z< or =92. Pratt, R.H.; Tseng, H.K.; Lee, C.M.; Kissel, L.; MacCallum, C.; Riley, M. (Department of Physics and Astronomy, University of Pittsburgh, Pittsburgh, Pennsylvania 15260). *At. Data Nucl. Data Tables;* **20**: No. 2, 175-209(Aug 1977).

A tabulation is presented of theoretical predictions for the electron bremsstrahlung energy spectrum from neutral atoms as a function of atomic number Z, incident electron kinetic energy T_1, and fraction of energy radiated K/T_1. Tabulated values were obtained by interpolation from a smaller set of calculated data points. These calculated points were obtained by describing bremsstrahlung as a single-electron transition in a relativistic self-consistent screened potential and, after expansions in partial waves, by performing a numerical evaluation for radial wavefunctions and matrix elements.

36216 Measurement of the total collisional ionization rates of Ne VI, VII, and VIII. Jones, L.A.; Kaellne, E.; Thomson, D.B. (Los Alamos Scientific Lab., NM). *J. Phys., B (London);* **10**: No. 2, 187-195(1977).

The total collisional ionization rates of neon VI, VII and VIII were measured in a time-evolving theta-pinch plasma. The method used was to calculate the expected emission from our plasma using the measured time- and space-dependent electron density (10^{16} - 10^{17} cm^{-3}) and temperature (120 to 400 eV). The semi-empirical ionization rates of Kunze and Lotz were used in the calculation and were adjusted, by multiplying with a constant, so that the predicted photon emission matched the observed line emission. The multiplicative factors, with estimated errors, required for best fit are: for neon VI, 0.15 +- 0.1; for neon VII, 0.4 +- 0.2; and for neon VIII, 0.7 +- 0.25. Also, a comparison is made between the semi-empirical rates used in this work and the recently calculated rates of Summers. These recently calculated rates were in good agreement with experiment for neon VII and VIII. For neon VI, however, the departure from experimental result was even farther than for the semi-empirical rate.

ATOMIC AND MOLECULAR THEORY

36217 (LBL—6016, pp 372-378) **Potential energy surfaces for chemical reactions.** Schaefer, H.F. III. 1976.

In Materials and Molecular Research Division annual report, 1976.

Research into potential energy surfaces for chemical reactions at Lawrence Berkeley Laboratory during 1976 is described. Topics covered include: the fuzzy interface between surface chemistry catalysis and organometallic chemistry; potential energy surfaces for elementary fluorine hydrogen reactions; structure, energetics, and reactivity of carbenes; and the theory of self-consistent electron pairs. (GHT)

36218 Relaxation to quantum-statistical equilibrium of the Wigner-Weisskopf atom in a one-dimensional radiation field. VIII. Emission in an infinite system in the presence of an extra photon. Davidson, R.; Kozak, J.J. (Department of Economics, Queen's University, Kingston, K7L 3N6, Canada). *J. Math. Phys. (N.Y.);* **19**: No. 5, 1074-1086(May 1978).

In this paper we study the emission of a two-level atom in a radiation field in the case where one mode of the field is assumed to be excited initially, and where the system is assumed to be of infinite extent. (The restriction to a one-dimensional field, which has been made throughout this series, is not essential: It is made chiefly for ease of presentation of the mathematical methods.) An exact expression is obtained for the probability rho (t) that the two-level quantum system is in the excited state at time t. This problem, previously unsolved in radiation theory, is tackled by reformulating the expression found in VII [J. Math. Phys. 16, 1013 (1975)] of this series for the time evolution of rho (t) in a finite system in the presence of an extra photon, and then constructing the infinite-system limit. A quantitative assessment of the role of the extra photon and of the coupling constant in influencing the dynamics is obtained by studying numerically the expression derived for rho (t) for a particular choice of initial condition. The study presented here casts light on the problem of time-reversal invariance and clarifies the sense in which exponential decay is universal; in particular, we find that: (1) It is the infinite-system limit which converts the time-reversible solutions of VII into the irreversible solution obtained here, and (2) it is the weak-coupling limit that imposes exponential form on the time dependence of the evolution of the system. The anticipated generalization of our methods to more complicated radiation-matter problems is discussed, and finally, several problems in radiation chemistry and physics, already accessible to exact analysis given the approach introduced here, are cited.

36219 Comparison of semiclassical treatments for evaluating Franck-Condon transition amplitudes for molecular dissociation. Band, Y.B.; Morse, M.D.; Freed, K.F. (Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* **68**: No. 6, 2702-2709(15 Mar 1978).

The full Franck-Condon amplitude for molecular dissociation processes can be written as a sum of products of half collision amplitudes, for vibrational-rotational transitions between single channel states of the repulsive electronic surface, and Franck-Condon (e.g., vertical) amplitudes, for transitions from the bound electronic state to the single channel states of the repulsive surface. The single channel Franck-Condon amplitudes, involving bound-continuum overlap integrals, are evaluated using various semiclassical approximations. A comparison is made between the semiclassical and exact quantum evaluations of the Franck-Condon single channel amplitudes by performing calculations for the photodissociation of HCN, ICN, and CO_2, thereby testing the range of validity of the semiclassical methods. Also, the wavelength dependence of the isotope effect for HCN dissociation is described.

36220 SCF potential curves for AlH and AlH^+ in the attractive and repulsive regions. Sabelli, N.H.; Kantor, M.; Benedek, R.; Gilbert, T.L. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *J. Chem. Phys.;* **68**: No. 6, 2767-2774(15 Mar 1978).

Self-consistent-field calculations have been carried out for the systems AlH and AlH^+ in their ground and excited states. Distances considered range from separated atoms and ions to 0.1 bohr, or $\Delta E \cong 2700$ eV. Additional calculations were performed to determine the effect of core and valence electrons at small internuclear separations. A comparison was made of the ab initio potential curve obtained for the $^1\Sigma^+$ state with results obtained from the Thomas-Fermi statistical model.

36221 Singlet-triplet energy separation for silaethylene. Hood, D.M.; Schaefer, H.F. III. (Department of Chemistry and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *J. Chem. Phys.;* **68**: No. 6, 2985-2986(15 Mar 1978).

Using the minimum basis SCF structure of Csizmadia and coworkers, the singlet triplet equilibrium geometries of silaethelene have been calculated. (AIP)

36222 Magnetic quadrupole transitions of the beryllium and magnesium isoelectronic sequences. Lin, C.D.; Laughlin, C.; Victor, G.A. (Center for Astrophysics, Harvard College Observatory and Smithsonian Astrophysical Observatory). *Astrophys. J.;* **220**: No. 2, 734-736(1 Mar 1978).

Accurate wave functions obtained from model potential methods are used to calculate the probabilities of the magnetic quadrupole transitions 2 $^3P_2 \rightarrow 2\ ^1S_0$ of the beryllium isoelectronic sequence and 3 $^3P_2 \rightarrow 3\ ^1S_0$ of the magnesium isoelectronic sequence. The results are compared with previous calculations.

36223 Molecular dynamics and Monte Carlo calculations in statistical mechanics. Wood, W.W.; Erpenbeck, J.J. (Los Alamos Scientific Lab., NM). *Annu. Rev. Phys. Chem.;* **27**: 319-348(1976).

Monte Carlo and molecular dynamics calculations on statistical mechanical systems is reviewed giving some of the more significant recent developments. It is noted that the term molecular dynamics refers to the time-averaging technique for hard-core and square-well interactions and for continuous force-law interactions. Ergodic questions, methodology, quantum mechanical, Lorentz, and one-dimensional, hard-core, and square and triangular-well systems, short-range soft potentials, and other systems are included. 268 references. (JFP)

GENERAL FLUID DYNAMICS

REFER ALSO TO CITATION(S) 35539

36224 Hydrocode convergence problem. Part 1. Hicks, D.L. (Sandia Labs., Albuquerque, NM). *Comput. Methods Appl. Mech. Eng.;* **13**: No. 1, 79-88(Jan 1978).

It is assumed that the following are given: a hydrocode producing numerical solutions to some discrete analog of the conservation laws of continuum mechanics, a p-law (relation between the pressure p and other variables), initial and boundary value data, and a mesh of points in space—time where the discrete solution is to be found by the hydrocode. The problem studied is whether or not the sequence of discrete solutions converges as the mesh is refined. Convergence can be proved in some cases as follows. For one-dimensional flows the problem can be split into three cases; in case n (n = 1, 2, 3) there is a system of n conservation laws. Further, case n divides into case nA and case nB--case nA assumes that the problem is well posed and the solution is smooth, and convergence can be proved in this case; case nB does not make these assumptions, and convergence has not been proved in general in this case. Thus, in case nB weak solutions (e.g. shock waves) are allowed. If the p-law allows p to depend only on the specific momentum, u, then the u-law (conservation of momentum) is the only one of the three conservation laws needed to determine the motion and case 1 results; if the p-law allows p to depend only on the specific volume, V, then the u-law and V-law (conservation of volume) are needed and case 2 results; if p depends only on V and the specific internal energy, E, then the u-law, V-law and E-law (conservation of energy) are needed and case 3 results. Solutions to the problem for cases nA (n = 1, 2, 3) and cases nB (n = 1, 2) are surveyed; then case 3B is studied and some results are presented. The results are referred to as motion compactness theorems. They follow from the embedding theorem of Sobolev spaces and show that the sequence of discrete motions is sequentially compact under assumptions appropriate to case 3B and, in particular, with the case when the p-law is the ideal gas law.

36225 Thermal evaluation regimes of mechanically agitated gas-solid fluidized beds. Rios, G.; Gibert, H. (Universite des Sciences et Techniques du Languedoc, Montpellier, France). *Can. J. Chem. Eng.;* **55**: No. 6, 666-671(Dec 1977). (In French).

The paper proposes a pattern of calculation permitting one to predict the thermal evolution of a gas-fluidized system which is mechanically stirred and subjected to abrupt fluctuations of the speed of the agitator. The two following cases are studied: (1) a full-fluidized system, and (2) a partly-fluidized system involving a dense portion of wall layer. The present work permits one to confirm the results obtained from the mechanical and thermal studies performed in a steady state; it also gives a valuable tool for designing automatic control systems intended for regulating the temperature of heterogeneous layers.

PROPERTIES AND STRUCTURE OF FLUIDS

36226 Effect of centrifuging on fluctuations in the critical liquid—liquid region. Alder, B.J.; Alley, W.E.; Beams, J.W.; Hildebrand, J.H. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *J. Chem. Phys.;* **68**: No. 7, 3099-3102(1 Apr 1978).

This paper presents a reassessment of an earlier paper on the elevation of the critical temperature, t/sub c/, of liquid—liquid mixtures in a centrifugal field and in a uniform pressure field. Two systems are used: one whose components have nearly the same density, the other whose densities differ widely. We find that with the first pair pressure raises t/sub c/ by the same amount whether applied by external compression or by a centrifuge, where the centrifugal force produces the same pressure. With the second pair there is a small additional increase in t/sub c/ which we attribute to stretching of the range of the thermal fluctuations. We confirm this effect and its magnitude by a theoretical analysis.

36227 Rayleigh-linewidth measurements near the critical point of a binary fluid. Sorensen, C.M.; Mockler, R.C.; O'Sullivan, W.J. (Department of Physics, Kansas State University, Manhattan, Kansas 66506). *Phys. Rev. Lett.;* **40**: No. 12, 777-780(20 Mar 1978).

We report careful measurements of the Rayleigh linewidth of light scattered from a critical binary fluid. Laser heating and multiple-scattering effects are accounted for. With use of independent data for ξ and the shear viscosity, a parameter-free fit is obtained with theory in the region $55 > k\xi > 0.32$. The renormalization-group—modified mode theory is shown to be necessary; however, we find a value of the dynamical exponent $z = 2.992 +- 0.014$ instead of 3.065.

36228 Shear viscosity via periodic nonequilibrium molecular dynamics. Ashurst, W.T. (Sandia Livermore Lab., CA); Hoover, W.G. *Phys. Lett.;* **61a**: No. 3, 175-177(2 May 1977).

Nonequilibrium molecular dynamic results of shear viscosity near the freezing density have a strain rate dependence that is best described by the Ree-Eyring hyperbolic arcsine relation. A square root dependence is not consistent with low gradient results or theoretical predictions. It is concluded that symmetry, experiment, calculation, and theory all favor the Ree-Eyring form.

SUPERFLUIDITY

36229 Theory of atomic scattering at the free surface of liquid ^{4}He. Edwards, D.O.; Fatouros, P.P. (Physics Department, The Ohio State University, Columbus, Ohio 43210). *Phys. Rev., B;* **17**: No. 5, 2147-2159(1 Mar 1978).

The scattering of free helium atoms at the surface of liquid ^{4}He at zero temperature is discussed in terms of the Feynman variational method. If the scattered atom is distinguishable from those in the liquid target, as is true for the scattering of ^{3}He, the problem reduces to the motion of a single particle in an effective potential. Above the surface the effective potential is the same as the real van der Waals potential and, in the surface and below, it is related to the density and kinetic-energy distribution in the liquid ground state. If the theory is applied to the scattering of ^{4}He, neglecting the indistinguishability of the scattered atom, an excellent fit to the experimental reflection coefficient is obtained. When the trial wave function is fully symmetrized to calculate the reflection coefficient for ^{4}He more realistically, the theory describes the production of a single excitation (phonon) from each absorbed atom. The resulting reflection coefficient disagrees with experiment, predicting total reflection at certain critical angles. Even when multiple production of low-energy phonons is considered, total reflection will still occur. It follows that the multiple production of some other type of excitation, in particular low-energy ripplons, must be a dominant process in agreement with the calculations of Echenique and Pendry. It seems that the simple unsymmetrized theory fits the data because the reflection coefficent is mainly determined by the static Van der Waals potential outside the liquid where the effects of symmetry, inelastic scattering, etc., are negligible. An atom which penetrates below this region is then effectively lost as far as the original beam is concerned because it begins to produce low-energy ripplons and is incoherently scattered. The problem of determining the density profile at the liquid surface from the experimental scattering data is briefly considered.

36230 Evidence for electronic ferromagetism in superfluid ^{3}He-A. Paulson, D.N.; Wheatley, J.C. (Department of Physics, University of California at San Diego, La Jolla, California 92093). *Phys. Rev. Lett.;* **40**: No. 9, 557-561(27 Feb 1978).

Experiments on ^{3}He-A show that the orientation of the orbital field l depends on the sign of the applied magnetic field, as if there were a ferromagnetic magnetization along l estimated by vertical-bar (10 mG)(1-T/T/sub c/) chi/sub N/ vertical-bar,in agreement with a recent prediction by Leggett.

PARTICLE INTERACTIONS AND PROPERTIES - EXPERIMENTAL

WEAK INTERACTIONS

36231 Properties of the hadronic system resulting from nu-bar/sub μ//sub p/interactions. Derrick, M.; Gregory, P.; Hyman, L.G.; Jaeger, K.; Lissauer, D.; Miller, R.J.; Musgrave, B.; Phelan, J.J.; Schreiner, P.; Singer, R.; Barish, S.J.; Engler, A.; Keyes, G.; Kikuchi, T.; Kraemer, R.; Barnes, V.E.; Carmony, D.D.; Garfinkel, A.F.; Laasanen, A.T. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., D;* **17**: No. 1, 1-15(1 Jan 1978).

The properties of the final-state hadronic system in antineutrino-proton charged-current interactions are presented. The events were observed in Fermilab 15-foot hydrogen bubble chamber. The average energy of the events is - 30 GeV, but there are some interactions beyond 100 GeV. The mean multiplicity of the charged hadrons varies as $\langle n/\text{sup h//sub c/}\rangle = (0.06 +- 0.60) + (1.22 +- 0.03)\ln W^2$ for hadronic masses W in the range $1.0 < W^2 < 50$ GeV^2. By contrast, the multiplicity depends only weakly on the four-momentum transfer between the leptons. The mean pion multiplicities for events with three or more charged tracks are found to be $\langle n/\text{sub -/}\rangle = 1.64 +- 0.04$, $\langle n_0\rangle = 1.16 +- 0.13$, for π^- and π^0 production, respectively. By comparing the number of positive tracks with π^- data from neutrino production, we deduce a mean proton multiplicity $\langle n/\text{sub p/}\rangle$ of 0.53 +- 0.15. The single-particle distributions in both longitudinal and transverse momentum are found to be similar to those for nondiffractive production in hadronic collisions. The fragmentation properties of the final-state d quarks are compared to the expectations of the quark-parton model. The fraction of observed neutral-strange-particle production for events with three or more charged tracks is 0.08 +- 0.015 and is consistent with coming completely from associated production.

STRONG BARYON-INDUCED INTERACTIONS

36232 Search for long-lived neutral heavy leptons in 400-GeV/c proton interactions. Bechis, D.J.; Chang, C.Y.; Dombeck, T.W.; Ellsworth, R.W.; Glasser, R.G.; Lau, K.H.; Sager, E.V.; Steinberg, P.H.; Teig, L.J. (University of Maryland, College Park, Maryland 20742). *Phys. Rev. Lett.;* **40**: No. 10, 602-604(6 Mar 1978).

We report a null search for neutral heavy leptons produced unaccompanied by muons in 400-GeV/c proton-nucleon collisions in a magnetized beam dump and decaying in vacuum downstream. The upper limit on σB for L^0's with Feynman $x >$ or ≈ 0.2 and θ/sub lab/ 9 or $\approx$ 10 mrad with branching ratio B into two charged particles is $\sigma B\ 9$ or $\approx 2.8 \times 10^{-35}$ cm^2/nucleon at the 90% confidence level for masses below 1.0 GeV/c^2 and lifetimes between 10^{-10} and 10^{-8} sec.

36233 Search for D^0(1865) mesons produced in association with prompt muons in hadrons interactions. Spelbring, D.; Gobbi, B.; Keren, J.; Lipton, R.; Rosen, J.; Ruchti, R.; Chaney, D.; Ferbel, T.; Mollet, W.; Slattery, P.; Underwood, D.; Bleser, E.; Johnson, D. (Northwestern Universit, Evanston, Illinois 60201). *Phys. Rev. Lett.;* **40**: No. 10, 605-607(6 Mar 1978).

We present the results of a search at Fermilab for the charmed meson, D^0 (1865), produced in association with a prompt muon by 300-GeV/c neutrons. We observe no significant enhancement in high-mass $K^{+-}\pi^{+-}$ systems and report, at the 95% confidence level, an upper limit of 200 nb/nucleon for the production of a pair of charmed particles and their subsequent decay into a K^{+-} +- state and a prompt muon.

36234 Search for leptons produced in association with prompt muons in hadronic interactions. Lipton, R.; Gobbi, B.; Keren, J.; Rosen, J.; Ruchti, R.; Spelbring, D.; Chaney, D.; Ferbel, T.; Mollet, W.; Slattery, P.; Underwood, D.; Bleser, E.; Johnson, D. (Northwestern University, Evanston, Illinois 60201). *Phys. Rev. Lett.;* **40**: No. 10, 608-611(6 Mar 1978).

We present the results of a search for leptons produced in coincidence with a prompt muon in neutron-beryllium collisions at 300 GeV/c. The experiments was sensitive to trigger muons and associated leptons of both low momentum and low transverse momentum. A clear $\mu^{+-}\mu^{-+}$ signal was found, but no significant $\mu^{+-}e^{-+}$ signal was observed. We report an upper limit for associated charmed-particle production [σ/sub CC/ xB(C $\rightarrow \mu +$ X) x B(C $\rightarrow$ e + x)] of < 340 nb/nucleon, at the 95% confidence level.

36235 Antiproton-proton charge exchange between 1 and 3 GeV/c. Cutts, D.; Good, M.L.; Grannis, P.D.; Green, D.; Lee, Y.Y.; Pittman, R.; Storer, J.; Benvenuti, A.; Fischer, G.C.; Reeder, D.D. (State University of New York, Stony Brook, New York 11794). *Phys. Rev., D;* **17**: No. 1, 16-23(1 Jan 1978).

We have measured the reaction cross section for p-barp $\rightarrow$ n-barn in small momentum steps between 0.97 and 3.13 Gev/c to a high level of statistical accuracy. Structures are observed in the vicinity of P/sub lab/ = 1.25 GeV/c and 1.8 GeV/c which are consistent with the structure observed in the p-barp total cross section.

36236 Measurement of proton-proton elastic scattering at 6 GeV/c in polarized initial and final spin states. Borghini, M.; de Boer, W.; Fernow, R.C.; Krisch, A.D.; Miettinen, H.E.; Mulera, T.A.; Roberts, J.B.; Terwilliger, K.M.; O'Fallon, J.R.; Ratner, L.G. (CERN, Geneva 23, Switzerland). *Phys. Rev., D;* **17**: No. 1, 24-41(1 Jan 1978).

The differential elastic p-p scattering cross section was measured at 6 GeV/c at the Argonne Zero Gradient Synchrotron in the range P/sub m/n = 0.60—1.0 (GeV/c)^2 using a 65% polarized target and a 75% polarized proton beam of intensity 3 x 10^9 protons/pulse. The polarization of the recoil proton was simul- taneously measured with a well calibrated carbon-target polarimeter. All three polarizations were measured perpendicular to the horizontal scattering plane. Our results indicate that P and T invariance are both obeyed to good precision even at our largest P/sub m/n^2. Parity invariance implies that the eight single-flip transversity cross sections are zero, so our data gives the magnitudes of the eight remaining pure spin cross sections where all spins are measured. We find that the four double-flip transversity cross sections are nonzero.

36237 Pion production from the pd $\rightarrow$ dπ^+n reaction at 585 MeV. Hogstrom, K.R.; Mutchler, G.S.; Witten, T.R.; Hudomalj-Gabitzsch, J.; Clement, J.M.; Felder, R.D.; Dragoset, W.H.; Madigan, W.P.; Buchanan, J.A.; Phillips, G.C.; Hungerford, E.V.; Mayes, B.W.; Pinsky, L.; Lee, L.Y.; Williams, T.M.; Allred, J.C. (T. W. Bonner Nuclear Laboratories, Rice University, Houston, Texas 77001). *Phys. Rev., C;* **17**: No. 1, 259-266(Jan 1978).

Pion production from the reaction ^{2}H(p,dπ^+) n was measured in a kinematically complete experiment at an incident proton energy of 585 MeV. The deuteron was detected with a magnetic spectrometer fixed at 35°. The pion was detected at seven angles from 30° to 90° lab angle. The data exhibit a broad peak in the deuteron momentum spectrum that decreases in magnitude and shifts to greater momentum with increasing pion angle.

STRONG MESON-INDUCED INTERACTIONS

36238 Limits on the production of unpaired electrons or positrons in 18-GeV/c π^{+-}p interactions. Ballam, J.; Bouchez, J.; Carroll, J.T.; Chadwick, G.B.; Cahloupka, V.; Field, R.C.; Freytag, D.R.; Lewis, R.A.; Moffeit, K.C.; Stevens, R.A.; Band, H.; Fourtney, L.R.; Glanzman, T.; Loos, J.S.; Robertson, W.J.; Walker, W.D.; Baker, P.A.; Dornan, P.J.; Gibbs, D.J.; Hall, G.; White, A.P.; Virdee, T.S. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev. Lett.;* **40**: No. 12, 741-744(20 Mar 1978).

Using the Standard Linear Acelerator Center Hybrid Facility 1-m bubble chamber with tantalum plates, a search was made for single electrons or positrons produced directly in 18-GeV/c π^{+-} interactions. At 90% confidence level (C.L.), $R = e^{+-}/\pi^{+-} < 2.4 \times 10^{-5}$. In addition, a limit can be set on charmed particle pair or associated production channels in terms of their semielectronic decay branching ratios, namely, $\sigma[R_1 + R_2] < 2.4$ μb at 90% C.L.

36239 Study of inclusive vector-meson production in π^-pinteractions at 15 GeV/c. Barreiro, F.; Benary, O.; Brau, J.E.; Grunhaus, J.; Hafen, E.S.; Hulsizer, R.I.; Karshon, U.; Kistiakowsky, V.; Lainis, T.; Levy, A.; Miller, P.A.; Napier, A.; Pless, I.A.; Silverman, J.P.; Trepagnier, P.C.; Yamamoto, R.K. (Laboratory for Nuclear Science, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev. Lett.;* **40**: No. 10, 595-598(6 Mar 1978).

We examine the polarization properties exhibited by rho^0'sand ω^0's in the reactions $\pi^- + p \rightarrow$ rho^0 + X^0 and π^- + rho $\rightarrow \omega^0$ + charged particles at 15 GeV/c. rho^0 production is analyzed in the framework of the triple Regge model. The trajectory coupled to the π^-rho^0 is α (t) = (-0.12 +- 0.07) + (0.78 +- 0.21)t in good agreement with the π trajectory. The properties of the system recoiling against the π^0 (off-shell "π^-"p reaction) are very similar to those of the final states of on-shell π^-p reactions at the same center-of-mass energy.

36240 Search for the reaction π^-p $\rightarrow$ psin near threshold. Jenkins, K.; Price, L.E.; Klem, R.; Miller, R.J.; Schreiner, P.A.; Courant, H.; Kagan, H.; Makdisi, Y.I.; Marshak, M.L.; Peterson, E.A.; Ruddick, K.; Walsh, T.J. (Columbia University, New York, New York 10027). *Phys. Rev., D;* **17**: No. 1, 52-54(1 Jan 1978).

We have searched for the reaction π^-p $\rightarrow$ psin near threshold. The search was motivated by the known strong enhancement in the analogous reaction π^-p $\rightarrow$ phin near threshold. No events were found, corresponding to an upper limit of 1.1 nb (90% confidence level) for the total production cross section.

36241 Reaction K^- + n $\rightarrow \Lambda^0 + \pi^-$ from 1550 to 1650 MeV. Morris, W.A.; Albright, J.R.; Colleraine, A.P.; Kimel, J.D.; Lannutti, J.E. (Florida State University, Tallahassee, Florida 32306). *Phys. Rev., D;* **17**: No. 1, 55-61(1 Jan 1978).

This paper presents the results of a study of the reaction K^-d $\rightarrow$ (p/sub s/) $\Lambda^0\pi^-$. The cross section for the process K^-n $\rightarrow \Lambda^0\pi^-$

has been measured as a function of the center-of-mass energy in the range from 1550 to 1650 MeV. An energy-dependent partial-wave analysis was performed for this reaction, and two acceptable solutions were found. The first solution indicated no resonant structure in this energy range below the Σ (1670). The second solution indicated resonant structure in the S_{11} partial wave with E/sub R/ = 1600 +- 6 MeV/c², Γ (E/sub R/) = 87 +- 19 MeV/c², and x = 0.12 +- 0.02.

36242 π^0 production in π^+ p interactions at 10.5 GeV/c. Elliott, J.R.; Fortney, L.R.; Goshaw, A.T.; Lamsa, J.W.; Loos, J.S.; Robertson, W.J.; Walker, W.D.; Yeager, W.M.; Dhar, S.; Sun, C.R. (Physics Department, Duke University, Durham, North Carolina 27706 Amherst, Massachusetts 01002). *Phys. Rev., D;* **17**: No. 1, 83-97(1 Jan 1978).

Inclusive γ and π^0 production is studied in π^+ p interactions at 20.5 Gev/c. The π^0 distributions are compared to those of π^+ and π^- mesons. An examination of the γ-γ mass spectrum confirms the relationship $\sigma(\pi^0) = \sigma(\gamma)/2$ to an accuracy of 10%. π^0 multiplicities and correlations are found to depend only weakly on charge multiplicity; for all inelastic collisions <n/sub π/> - 1.50 +- 0.05 and f^{00}_2 =-0.05 +- 0.06. The π^+, π^0, and π^- spectra are found to be similar in form when compared differentially in terms of the Feynman x variable. $d\sigma/dx$ (π^0) is bounded by the π^+ and π^- cross sections for all values of x.

PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL

GENERAL

36243 Properties of hadron distributions in reactions containing very heavy quarks. Bjorken, J.D. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **17**: No. 1, 171-173(1 Jan 1978).

We study, in the framework of the naive quark-parton model, production and decay dynamics for processes containing a very heavy quark Q of a new flavor, decaying via weak interactions. We argue the following. (i) The event-by-event distribution of hadrons is similar to what would exist in a similar direct process involving the same produced partons (with the same momenta), but not involving a cascade decay. (ii) For neutrino production, electroproduction, and e^+e^- annihilation, at energies far above threshold, the inclusive momentum distribution of a stable hadron H containing the Q peaks near the maximum momentum, i.e., at values of the scaling variable z ~ 1. (iii) For events containing a nonleptonic decay of Q into ordinary quarks via Q → qq-barq, the leading hadron distribution is characterized by multiplicity ~3 times normal multiplicity, as well as abnormally large transverse momenta.

36244 Hadronic decays of charmed mesons. Quigg, C.; Rosner, J.L. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev., D;* **17**: No. 1, 239-247(1 Jan 1978).

Hadronic branching fractions for the charmed mesons D^0, D^+, and the expected F^+ are predicted on the basis of models embodying a minimum of dynamical assumptions. These models entail average decay multiplicities between 3 and somewhat over 4. Suggestions are made for observing the F^+, for which the wide variety of available final states makes detection in any one state challenging. The branching ratio Γ ($F^+ \to K^+K^-\pi^+$)/ Γ ($F^+ \to$ hadrons) is probably 9 or ≈ 3—6%; Γ ($F^+ \to K^+$ K-bar^0)/Γ ($F^+ \to$ hadrons) 9 or ≈ 4— 6%;Γ ($F^+ \to \pi^+$ eta)/Γ ($F^+ \to$ hadrons) 9 or ≈ 3—4%.

36245 Unconfined quarks and gluons. De Rujula, A.; Giles, R.C.; Jaffe, R.L. (The Physics Laboratories, Harvard University, Cambridge, Massachusetts 02138). *Phys. Rev., D;* **17**: No. 1, 285-301(1 Jan 1978).

We explore the possibility that fractionally charged colored quarks and electrically neutral colored gluons may exist as real particles. Our framework is a renormalizable, spontaneously broken version of color dynamics [quantum chromodynamics (QCD)], in which the gluons are given a common mass μ in the Lagrangian. Color SU(3) remains an exact global symmetry, and for small μ our understanding of color-singlet hadrons in QCD is unaltered. For small μ the masses of physical quarks and gluons are large: O $((2\pi\alpha'\mu)^{-1})$ with α' the slope of Regge trajectories. There is at least one stable hadron for every representation of color SU(3). In the unbroken QCD limit (μ → 0) the conventional picture of color confinement is recovered. To implement quasiconfinement in detail we use the MIT bag model. For μ = 0 this model describes confinement. For μ not = 0, it describes quasiconfinement with no further modification. Production cross sections for quarks and gluons turn out to be very small. Quark-nucleon and gluon-nucleon cross sections, on the other hand, are very large. Quarks and gluons have a large nuclear appetite: Sequential absorption of nucleons by a free quark is exothermic up to large values of total baryon number. If quarks are very heavy, primordial quarks left over from the big bang will be found in superheavy quark-nucleon complexes with large nonintegral charge and baryon number. Primordial gluons will have the appearance of integrally charged superheavy nucleon complexes.

36246 Dynamic polarizability of the sine-Gordon soliton. Fogel, M.B.; Trullinger, S.E.; Bishop, A.R. (Cornell Univ., Ithaca, NY). *Phys. Lett.;* **59a**: No. 2, 81-83(15 Nov 1976).

A recently-developed perturbation theory to examine the rsponse of a sine-Gordon soliton to an oscillating driving force in the presence of damping. The real and imaginary parts of the "polarizability" are plotted and it is concluded that the soliton behaves very much like a classical deformable particle.

ELECTROMAGNETIC INTERACTIONS

36247 (ORO—3992-307) **Light on light: Satyendra Nath Bose's work on radiative equilibrium.** Sudarshan, E.C.G. (Texas Univ., Austin (USA). Center for Particle Theory). Jun 1977. Contract EY-76-S-05-3992. 31p. Dep. NTIS, PC A03/MF A01.

The discussion of radiative equilibrium covers electromagnetic theory, photons, statistical mechanics of a photon gas, Bose-Einstein statistics, Bose processes as an innovation on a Poisson process, Einstein's dynamic derivation for Bohr atoms, Bose's generalized dynamic derivation, dynamical theory of radiative equilibrium, partial coherence, quantum field theory, and Bose condensation. (JFP)

36248 p-barp interactions at 2.32 GeV/c. Chen, C.K.; Fields, T.; Rhines, D.S.; Whitmore, J. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., D;* **17**: No. 1, 42-51(1 Jan 1978).

A bubble-chamber experiment based on 304 000 events of p-barp interactions at 2.32 GeV/c is described. The film was automatically scanned and measured by the POLLY II system. Details of the data-analysis methods are given. We report results on cross sections for constrained final states, tests of C invariance, and inclusive pion and rho^0 multiplicity parameters for annihilation final states.

36249 Vector-meson-exchange and unitarity effects in low-energy photoproduction. Olsson, M.G.; Osypowski, E.T. (University of Wisconsin, Physics Department, Madison, Wisconsin 53706). *Phys. Rev., D;* **17**: No. 1, 174-184(1 Jan 1978).

Vector-meson-exchange effects are investigated for photoproduction in the Δ region. An improved analysis using a current-algebra model with unitarity corrections and the most recent multipole analysis indicates the necessity of vector-meson contributions. The required vector-meson coupling constants are consistent with quark-model values.

36250 Measurement of the antiproton magnetic moment and mass. Roberts, B.L. (College of William and Mary, Williamsburg, Virginia 23185). *Phys. Rev., D;* **17**: No. 1, 358-360(1 Jan 1978).

We report a reanalysis of our p-bar x-ray data from Pb and U for fine-structure splitting and have included perturbations to the p-bar-atomic energy levels arising from radiative corrections, relativistic effects, electron screening, finite nuclear size, and nuclear recoil. The value for the antiproton magnetic moment is -2.817 +- 0.048 nuclear magnetons which is 0.1% lower than our previous result and in agreement with the CPT prediction of -2.793. In addition we have obtained a value for the p-bar mass from the measured p-bar-Pb x-ray transition energies from n = 15 to n = 10. The resulting mass 938.30 +- 0.13 MeV is in good agreement with the CPT prediction that the p-bar mass should equal the proton mass. We find m/sub p/ - m/sub p/ = -0.02 +- 0.13 MeV.

36251 Transverse-momentum limitation in inclusive electroproduction processes. Pak, N.K. (Stanford Linear Accelerator Center, Calif. (USA)). *Nuovo Cim., A;* **39**: No. 4, 570-575(21 Jun 1977).

It is shown that, if the longitudinal phase space is populated in a statistically independent manner (Poisson-like distribution), in an interval between the limits fixed by the rapidity of the leading particles, one being the virtual photon, then the average transverse momentum must be limited in the Bjorken limit, and this limit is scale invariant. As a result it is further shown that the average density of particles (the rate of increase of average multiplicity with ln s) has a universal upper bound independent of dynamical variables.

36252 Electromagnetic interactions with emphasis on colliding rings, partons, and the light cone. Drell, S.D. (Stanford Univ., CA). pp 307-332 of International conference on elementary particles. Amsterdam; North-Holland (1971).

Electron-positron annihilation is studied in colliding beams illustrating the parton model for protons. The partons are seen as propagating in long-lived almost reak an free states if advantage is taken of the time dilation by boosting to a very rapidly moving reference frame known as the infinite momentum frams. 74 references. (JFP)

WEAK INTERACTIONS

36253 Does the heavy charged lepton have its own neutrino. Donoghue, J.F.; Wolfenstein, L. (Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). *Phys. Rev., D;* **17**: No. 1, 224-228(1 Jan 1978).

In SU x U(1) theories with both left-handed and right-handed lepton doublets, we show that the new charged heavy lepton must have its own neutrino. Experiments are discussed which would force a similar conclusion in theories with only left-handed doublets.

STRONG INTERACTIONS, GENERAL

REFER ALSO TO CITATION(S) 35887, 35888, 35891

36254 Hadronic production with a Drell-Yan trigger. DeGrand, T.A.; Miettinen, H.I. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev. Lett.;* **40**: No. 10, 612-615(6 Mar 1978).

The ratio of cross sections for producing fast π^+'sand π^-'s in association with a massive dilepton should be a strongly varying function of the mass of the pair, reducing at small mass to its value in the absence of a pair. For M/sub mumu/^{2}/s > 0.1, the π^+/π^- ratio should fall by a factor of 1.7 in the reactions $p + p \rightarrow \pi + (\mu^+\mu^-) + X$ and $p + \pi^- \rightarrow \pi + (\mu^+\mu^-) + X$, rise by a factor of 2.6 in $p + \pi^+ \rightarrow \pi + (\mu^+\mu^-) + X$, and fall by about 25% in $p + p \rightarrow \pi + (\mu^+\mu^-) + X$.

36255 Modified quantum chromodynamics: Exact global color symmetry and asymptotic freedom. Ma, E. (Department of Physics and Astronomy, University of Hawaii at Manoa, Honolulu, Hawaii 96822). *Phys. Rev., D;* **17**: No. 2, 623-628(15 Jan 1978).

A theory of modified quantum chromodynamics is presented in which color is realized as a global rather than local SU(3) symmetry. Quarks and gluons are then free to exist, but below a certain energy threshold they are still effectively confined by the same dynamics as in quantum chromodynamics. In addition to the massive vector-gluon octet, the theory also contains an octet and two singlets of Higgs particles, or scalar gluons. Asymptotic freedom is maintained by the imposition of eigenvalue conditions on all coupling constants such that only one of them, say the gauge coupling g, is an independent parameter. This is shown to imply the existence of extraordinary quarks which are not triplets under color SU(3).

36256 Adler-Weisberger relation and the quark model. Donoghue, J.F.; Wyler, D. (Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213). *Phys. Rev., D;* **17**: No. 1, 280-284(1 Jan 1978).

We domonstrate consistencies between two seemingly different methods of calculating the axial-vector coupling constant g/sub A/.

36257 Hadronic deformation energy. I. Quark-antiquark separation. DeTar, C. (Center for Theoretical Physics, Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., D;* **17**: No. 1, 302-322(1 Jan 1978).

The MIT bag model for hadrons is treated in the static cavity approximation in three dimensions with a definite quark number. The energy of the system is computed to second order in the gluon coupling. A constrained variational method is described which permits the calculation of the energy as a function of a collective variable. The bag cavity is permitted to assume whatever shape of a general class is necessary in order to minimize the energy for a given expectation value of the collective variable. The method is well suited for the study of the two-nucleon interaction at short range. By way of introducing the computational procedure the method is here applied to a bag containing one quark and one antiquark and the energy as a function of a measure of the separation of the quarks is evaluated.

36258 Hadronic deformation energy. II. Two-nucleon interaction. DeTar, C. (Center for Theoretical Physics, Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., D;* **17**: No. 1, 323-339(1 Jan 1978).

The MIT bag model for hadrons is treated in the static cavity approximation. The adiabatic deformation of a six-quark hadron with quantum numbers of the deuteron is studied in a configuration which permits the separation of two triplets with quantum numbers of the neutron and proton. The energy of the system is computed to second order in the gluon coupling and presented as a function of two choices of a single collective variable: a separation parameter for the nucleons and the baryonic quadrupole moment. The present study considers only interactions at short and intermediate range in a state with nuclear spins aligned in parallel along the deformation axis. It does not treat effects depending on nucleon momenta. The energy, when expressed in terms of a nuclear separation parameter exhibits a soft repulsive core at short range due to a color-magnetic gluon interaction, and strong attraction in intermediate range due to a color-electric interaction.

STRONG INTERACTIONS, BARYON NO.=1

REFER ALSO TO CITATION(S) 36252

36259 Two-component Pomeron and hadron total cross sections and real parts. Lipkin, H.J. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., D;* **17**: No. 1, 366-368(1 Jan 1978).

The predictions from a five-parameter formula obtained from a two-component Pomeron model and fit to hadron-nucleon total cross sections from 2 to 200 GeV/c are in remarkable agreement with new CERN ISR data on total proton-proton cross sections and real parts up to an equivalent P/sub lab/ of 2000 GeV/c and with total-cross-section data from cosmic rays up to 40 000 GeV/c. This oversimplified formula with a Regge term varying as s/sup -1/2/, two Pomeron-like terms with slightly increasing and slightly decreasing power behavior, and dependence upon quantum numbers given by simple quark-counting rules is adequate to fit all available data and can be useful for analysis of future data. Predictions for the ratios of real to imaginary parts of π^{+-}p, K^{+-}p, and p^{+-}p forward amplitudes are given.

36260 Pion-nucleon form factor in the Chew-Low theory. Ernst, D.J.; Johnson, M.B. (Physics Department, Texas AandM University, College Station, Texas 77843). *Phys. Rev., C;* **17**: No. 1, 247-258(Jan 1978).

We find a solution to the static Chew-Low theory of pion-nucleon scattering, avoiding the "one-meson approximation." Our basic equation is crossing symmetric and may be solved for phase shifts δ (p) by standard numerical techniques, upon specifying a form factor v (p) and a set of inelasticities. With v (p) = exp(-p^2/30) we reproduce experimental δ (p) for p/sub L/ < or = 1.2 GeV/c in the (3,3) state; in the (1,3) states and (3,1) states δ (p) compare well on the average but in the (1,1) state δ (p) have opposite signs. We show the importance of crossing symmetry and the coupling to inelastic channels, and we discuss the possibility of determining v (p) directly from elastic scattering by an inverse scattering formula.

STRONG INTERACTIONS, BARYON NO. GREATER THAN 1

36261 Quantum-chromodynamic gluon contributions to large-p/sub T/ reactions. Cutler, R.; Sivers, D. (High Energy Physics Division, Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., D;* **17**: No. 1, 196-211(1 Jan 1978).

We use a calculation based on the lowest order in the perturbation series for quantum chromodynamics to obtain an estimate for the contribution of hard-scattering processes involving vector gluons to the production of hadrons at large transverse momentum. Some simple models for the distribution of gluons in a proton and for the distribution of hadrons within a hard gluon jet are presented and used to calculate the process $pp \rightarrow \pi^0 X$. At $\sqrt{s} = 53$ GeV we find that the contribution of the subprocess $qV \rightarrow qV$ is comparable to that of $qq \rightarrow qq$. The resulting cross sections are rather close to the CERN ISR data in magnitude. It is possible that small corrections arising, for example, from higher-order terms in the perturbation expansion might lead to a detailed fit to these data. At higher energies, such as those to be obtained in proposed new experimental facilities, our results indicate that the mechanisms $VV \rightarrow VV$ and $qV \rightarrow qV$ may dominate over $qq \rightarrow qq$ in much of the accessible kinematic regime. We briefly consider some experimental consequences of possible gluon dominance.

PARTICLE INVARIANCE PRINCIPLES AND SYMMETRIES

GENERAL

36262 Hypermomentum in hadron dynamics and in gravitation. Hehl, F.W.; Lord, E.A.; Ne'eman, Y. (Institute for Theoretical Physics, University of Cologne, D-5000 Cologne 41, Federal Republic of Germany). *Phys. Rev., D;* **17**: No. 2, 428-433(15 Jan 1978).

The infinite unitary irreducible spinor representations of the SL(3,R) algebra of hadron excitations are embedded in a global GA(4,R) with intrinsic dilation, shear, and spin pieces in its hypermomentum current (i.e., the affine generalization of angular momentum). When gauged over a space with a local Minkowski metric, GA(4,R) reproduces the metric-affine theory of gravity, in which the intrinsic hypermomentum is coupled to the connection, and the energy-momentum to the tetrad.

36263 Nambu mechanics of non-Abelian dyons. Hirayama, M.; Tze, H.C. (Stanford Linear Accelerator Center, Stanford University,

Stanford, California 94305). *Phys. Rev., D;* **17**: No. 2, 546-556(15 Jan 1978).

Non-Abelian toplike realizations of Nambu's mechanics are found in nonrelativistic bound systems of a point singular SU(2) monopole and a test particle bearing G spin embedded in a general compact gauge group G. The exactly soluble cases of G = U(1), SU(2), and SU(3) dyons are studied in detail. The naturalness of the new formalism for these Keplerian systems is exhibited.

FIELD THEORY

36264 Cluster expansion for lattice gauge theories with fermions. Challifour, J.L.; Weingarten, D. (Physics Department, Indiana University, Bloomington, Indiana 47401). *J. Math. Phys. (N.Y.);* **19**: No. 5, 1134-1136(May 1978).

A cluster expansion is constructed for Euclidean lattice gauge theories including fermions. For sufficiently small values of the bare qauge coupling constant g^{-2} and the fermion propagation constant k, we prove the existence of gauge invariant infinite volume vacuum expectation values, convergence of Wilson's strong coupling expansion, and an inequality related to quark confinement.

36265 Derivation of a quark-confinement equation in the Hamiltonian formalism of gauge field theories. Suura, H. (School of Physics and Astronomy, University of Minnesota, Minneapolis, Minnesota 55455). *Phys. Rev., D;* **17**: No. 2, 469-482(15 Jan 1978).

Using the Hamiltonian formalism of gauge field theories I derive a quark-confining wave equation for a gauge-invariant amplitude describing a system of a quark and an antiquark connected by a linear electric flux. I obtain an exact potential in the form of the Brillouin-Wigner series, which I make finite and well defined by introducing a finite radius to the tube of the electric flux as a dynamical parameter, to be determined from the stability of the solution. The potential is shown to vanish at the origin and become linear at a large distance. The confinement solution is compared with the normal positronium solution to the wave equation with the Coulomb potential, and the latter is shown the stabler of the two for g/sub r/$^2/4\pi$ < 2 where g/sub r/ is the renormalized coupling constant. For g/sub r/$^2/4\pi$ > 2, the confinement solution is the only possible one. Essential differences between Abelian and non-Abelian gauge fields are pointed out. A possibility of g/sub r/ being replaced by g/sub eff/ in the sense of asymptotic freedom is pointed out also.

36266 Self-dual Yang-Mills fields in Minkowski space-time. Rebbi, C. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., D;* **17**: No. 2, 483-485(15 Jan 1978).

We exhibit a complex, self-dual gauge field configuration in Minkowski space-time, with the property that its real part satisfied the Yang-Mills equations of motion.

36267 Vacuum tunneling of gauge theory in Minkowski space-time. Bitar, K.M.; Chang, S. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev., D;* **17**: No. 2, 486-497(15 Jan 1978).

We study vacuum tunneling of non-Abelian gauge theory directly in Minkowski space. We do this by constructing a family of field configurations which connects vacuums of different winding numbers and which satisfies conditions necessary and sufficient to produce maximum tunneling amplitude. Using these explicit configurations we obtain explicitly the potential-energy barrier in winding-number space, through which tunneling occurs. We finally discuss the possible connections among the tunneling solution, the classical solution, and the full quantum-mechanical solution to the field equations.

36268 Lower bounds for quantum Hamiltonians in lattice field theories. Blankenbecler, R.; Fulco, J.R. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **17**: No. 2, 514-522(15 Jan 1978).

A method for approximately including quantum effects on the solution to lattice field theories is presented. The formalism is an extension of the semiquantum approximation of Sachrajda, Weldon, and Blankenbecler to obtain lower bounds for quantum Hamiltonians. This approach yields classical-like equations in which the effects of quantum fluctuations is included in a variational manner. The energies obtained by this method should be lower bounds to the true eigenvalues. Vacuum and single-kink solutions are treated in detail, both analytically and numerically.

36269 Fermion field theory on a lattice: Variational analysis of the Thirring model. Drell, S.D.; Svetitsky, B.; Weinstein, M. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **17**: No. 2, 523-536(15 Jan 1978).

We extend variational techniques previously described to study the two-dimensional massless free fermion field and the Thirring model on a spatial lattice. The iterative block spin procedure of constructing an effective lattice Hamiltonian, starting by dissecting the lattice into three-site blocks, is shown to be successful in producing results known for the continuum Thirring model.

36270 Poincare- and gauge-invariant two-dimensional quantum chromodynamics. Bars, I.; Green, M.B. (Department of Physics, Yale University, New Haven, Connecticut 06520). *Phys. Rev., D;* **17**: No. 2, 537-545(15 Jan 1978).

We present a canonical formulation of two-dimensional quantum chromodynamics in the axial or Coulomb gauge A/sup a/$_1$ = 0. For consistency with the Lagrange equations of motion, the Hamiltonian must include a nontrivial dynamical background electric field term. This breaks translation invariance inthe gauge-noninvariant sector. We argue, however, that for the purpose of calculating gauge-invariant physical quantities one can consider the naive theory defined by the Feynman rules without the background electric field. We show that the naive theory has an anomalous Poincare algebra due to its non-Abelian character; the theory is Lorentz invariant only in the color-singlet sector. Because of this fact the quark propagator has a noncovariant pole, and the iε prescription is different from the naive one. In the N → ∞ limit (where N is the number of colors) we can set up a two-component Bethe-Salpeter equation in the color-singlet sector to determine the spectrum of the theory. The resulting equation has an obvious interpretation in terms of forward- and backward-moving strings, and leads to the same spectrum of bound states as that obtained by 't Hooft in the light-cone gauge.

36271 Remarks on the implementation of Gauss's law in the A_0 = 0 gauge. Willemsen, J.F. (Center for Theoretical Physics, Laboratory for Nuclear Science and Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., D;* **17**: No. 2, 574-584(15 Jan 1978).

A naive implementation of the residual gauge invariance of (continuum) QED in the A = 0 gauge leads to charged-particle nonpropagation in space. It is shown that the Ward-Takahashi identities leading to this result are false. Rather, Gauss's law supplants these false identities, and implies that it is only the longitudinal modes of the Maxwell field that are rendered immobile by gauge invariance. Analogous results are conjectured to hold in quantum chromodynamics.

36272 Nonrenormalizable interactions and eigenvalue condition. Eguchi, T. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **17**: No. 2, 611-615(15 Jan 1978).

It is pointed out that a certain class of nonrenormalizable theories can be made renormalizable if a theory possesses an ultraviolet-stable fixed point. As an example, four-fermion theories of the Nambu-xnJona-Lasinio-type are considered.

SCATTERING THEORY

36273 (LBL—6199) **Multiperipheral ring dynamics and a definition of the complete twisted Reggeon loop.** Lucht, P.H. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1977. Contract W-7405-ENG-48. 130p. Dep. NTIS, PC A07/MF A01.

Thesis.

The t less than 0 multiperipheral formalism of Ciafaloni, DeTar, Misheloff, Mueller, Muzinich and Yesian is reviewed, extended, and applied to the ordered S-matrix whose ring amplitudes comprise the zeroth level of the topological expansion. Toller M-function notation is used throughout. The bootstrap and cylinder problems are formulated in terms of a well defined helicity pole propagator; a definition of the complete twisted Reggeon loop, which appears in the one-twist term of the cylinder, is given as a helicity pole expansion. Some consideration is given to the following subjects: diagonalization, naturality, threshold behavior, Regge cuts, and complex helicity.

PHYSICS RESEARCH (CONT.)

NUCLEAR PHYSICS

36274 (TID—28328) **Annual report, 1975.** (Texas Univ., Austin (USA). Center for Nuclear Studies). 1975. Contract EY-76-C-05-2972. 87p. Dep. NTIS, PC A05/MF A01.

This document is the final report for the contract which has principally supported the experimental program using the 6 MV tandem electrostatic accelerator at the Center for Nuclear Studies of the University of Texas at Austin.

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

36275 (TID—28325) **Technical progress report [high energy physics research], 1977—1978.** (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA). Dept. of Physics). 1978. Contract EY-76-S-05-4928. 7p. Dep. NTIS, PC A02/MF A01.

Research progress is reported for analysis of p-p, n-p, π^{+-} p, k^+ p, and isobar analysis of πN pion production. (SDF)

NUCLEAR PROPERTIES AND REACTIONS, A=1-5, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

36276 **d + d four-body breakup reaction at 80 MeV.** Leeman, B.T.; Pugh, H.G.; Chant, N.S.; Chang, C.C. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Phys. Rev., C;* **17**: No. 1, 410-413(Jan 1978).

The d + d four-body breakup reaction has been studied in a geometry chosen to emphasize the double spectator process. Data were obtained at a bombarding energy of 80 MeV for the coincident detection of both emitted protons at several equal angle pairs. Comparison with simple plane wave Born approximation calculations suggests that, in addition to the double spectator process, another process, more strongly localized in phase space, is important. It is suggested that such a process is the double spin-flip excitation of both deuterons to the singlet state.

NUCLEAR PROPERTIES AND REACTIONS, A=6-19, EXPERIMENTAL

RADIOACTIVE DECAY

36277 **Beta-ray branching and half-lives of ^{12}B and ^{12}N.** Alburger, D.E.; Nathan, A.M. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., C;* **17**: No. 1, 280-286(Jan 1978).

The ratio of ^{12}B and ^{12}N β-ray branches to the 4.44-MeV excited state of ^{12}C was measured by detecting β rays in a 4π plastic scintillator and γ rays in two Ge(Li) detectors. Activities were made in the ^{11}B(d,p)^{12}B and ^{10}B(^{3}He,n)^{12}N reactions using a chopped Van de Graaff beam. Data were stored in two successive computer time bins of two half-lives each in order to establish by subtraction the shape of the short-lived β-ray spectrum and its net number of counts. The ratio of these branches was found to be ^{12}N/^{12}B = 1.56 +- 0.05. A measurement of the ^{12}B absolute β-ray branch to the 4.44-MeV state via β-γ coincidences using an NaI(Tl) detector for the γ rays gave a value of 1.276 +- 0.050%. Half-lives, obtained by multiscaling β-ray counts, were found to be 20.20 +- 0.02 msec for ^{12}B and 11.000 +- 0.016 msec for ^{12}N. The mirror asymmetries derived from these results are δ = +0.044 +- 0.034 for the decay to the 4.44-MeV state of ^{12}C and δ = +0.129 +- 0.008 for the branch to the ground state.

NUCLEAR REACTIONS AND SCATTERING

36278 **Measurement of the differential elastic and inelastic neutron scattering cross sections of carbon from 8.0 to 14.5 MeV.** Haouat, G.; Lachkar, J.; Sigaud, J.; Patin, Y.; Cocu, F. (Centre d'Etudes de Bruyeres-le-Chatel, Montrouge, France). *Nucl. Sci. Eng.;* **65**: No. 2, 331-346(Feb 1978).

Measurements of differential cross sections for fast neutrons scattered by carbon are presented for 14 incident neutron energies between 8.0 and 14.5 MeV. The measurements were performed with the four-detector neutron time-of-flight facility of the Centre d'Etudes de Bruyeres-le-Chatel tandem Van de Graaff accelerator. The angular distributions for elastic and inelastic scattering to the first excited level of ^{12}C were obtained over the angular range from 10 to 160°. The experimental uncertainties vary from 7 to 15% for the differential elastic scattering cross sections and from 8 to 22% for the differential inelastic scattering cross sections. These measurements partially fill in an energy range that was previously characterized by a lack of data. The angle-integrated cross sections are compared to the evaluated values of ENDF/B, and significant discrepancies are shown. The present data were included in an evaluation work on carbon carried out in this laboratory. The consistency of total cross-section measurements with our data and other partial cross sections is discussed.

36279 **Scattering of polarized tritons by ^{9}Be and ^{12}C.** Schmelzbach, P.A.; Hardekopf, R.A.; Haglund, R.F. Jr.; Ohlsen, G.G. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., C;* **17**: No. 1, 16-23(Jan 1978).

The differential cross section and the analyzing power A/sub y/ for ^{9}Be(t,t)^{9}Be and ^{12}C(t,t)^{12}C elastic scattering have been measured at 15 and 17 MeV over the angular range θ/sub lab/ = 17.5—165.0°. The data in the forward hemisphere have been analyzed with a standard optical model. A large depth and conventional geometry parameters for the spin-orbit potential have been found. The results of the present analysis are in general agreement with previous work involving polarized tritons scattered from heavy target nuclei and show important differences from investigations of the scattering of polarized helions on light nuclei.

36280 **Pion-induced single-nucleon removal to discrete final states.** Morris, C.L.; Boudrie, R.L.; Kraushaar, J.J.; Peterson, R.J.; Ristinen, R.A.; Smith, G.R.; Bolger, J.E.; Braithwaite, W.J.; Moore, C.F.; Smith, L.E. (University of Virginia, Charlottesville, Virginia 22901). *Phys. Rev., C;* **17**: No. 1, 227-236(Jan 1978).

Gamma radiation from targets of ^{7}Li, ^{9}Be, ^{12}C, ^{13}C, and ^{16}O bombarded by π^- and π^+ at energies between 60 and 300 MeV was uniquely associated with states formed by removing a single nucleon by the $(\pi,\pi N)$ reaction. All yields were found to reflect the well-known 3-3 resonance near 180 MeV in the pion-nucleon system. Ratios of yields for π^- and π^+ beams were measured for ^{7}Li, ^{9}Be, and ^{13}C. These ratios were very similar to one another and to previous results on ^{12}C, ^{14}N, and ^{16}O for neutron removal. Several reaction mechanisms based on quasifree processes are tested by comparison to the data, and all are rejected.

36281 **Cross sections for gamma-ray production by 14-MeV neutrons.** Drake, D.M.; Arthur, E.D.; Silbert, M.G. (Los Alamos Scientific Lab., NM). *Nucl. Sci. Eng.;* **65**: No. 1, 49-64(Jan 1978).

Cross sections for the production of gamma rays by bombardment with 14.2-MeV neutrons were measured for 20 samples ranging from beryllium to plutonium. Differential cross sections are given as a function of gamma-ray energy over the region from 0.2 to 9.0 MeV for angles between the incident neutrons and emitted photons of 90 to 130 deg. For some of the light elements, cross sections are also presented for individual gamma rays. Pulsed-beam neutron time-of-flight techniques were employed to reduce background effects in the large NaI(Tl) gamma-ray spectrometer.

36282 **Differential elastic scattering cross sections of boron-10 for neutrons of 4 to 8 MeV energy.** Knox, H.D.; White, R.M.; Lane, R.O. (Ohio Univ., Athens). *Nucl. Sci. Eng.;* **65**: No. 1, 65-69(Jan 1978).

Differential neutron cross sections of ^{10}B for elastic scattering have been measured for approximately 30 incident neutron energies between 4 and 8 MeV. Neutrons inelastically scattered from the 0.717-MeV level were completely resolved from the elastic group except at the most forward angles at energies above 7.5 MeV. Generally, the differential cross sections are slowly varying with energy, indicating little resonance structure in this region. These data are consistent with earlier lower energy measurements done at Edwards Accelerator Laboratory and provide detailed data in a region where only sparse data were previously available to evaluators and designers in the nuclear energy field.

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

36283 **Giant quadrupole resonance in /sup 24,26/Mg: A comparison of inelastic-scattering and α-capture experiments.** Bertrand, F.E.; van der Borg, K.; Drentje, A.G.; Harakeh, M.N.; van der Plicht, J.; van der Woude, A. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev. Lett.;* **40**: No. 10, 635-638(6 Mar 1978).

The distribution of giant quadrupole resonance strength in / sup 24,26/Mg obtained from inelastic α- and proton-scattering experiments and α-capture experiments have now been shown to be compatible. The results show that the giant quadrupole resonance strength in ^{24}Mg and ^{26}Mg is fragmented into several states or clusters of states and suggest that the giant quadrupole resonance states have very different α_0-decay strength.

36284 **(^{6}Li,t) reaction on medium-mass nuclei and the mass and spectrum of ^{61}Zn.** Woods, C.W.; Stein, N.; Sunier, J.W. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev., C;* **17**: No. 1, 66-74(Jan 1978).

The (^{6}Li,t) reaction was studied with a 34-MeV ^{6}Li beam on enriched targets of ^{24}Mg, ^{28}Si, ^{54}Fe, ^{56}Fe, and ^{58}Ni. The tritons were momentum analyzed in a quadrupole-dipole-dipole-dipole magnetic spectrograph and detected with a 1-m helical cathode proportional counter that covered about 4 MeV of excitation. Cross sections for the (^{6}Li,t) reaction to strongly excited states are generally in the range of 1 to 10 μb/sr with exceptions up to 50 μb/sr.

Comparisons are made, where possible, between the selectivity of this reaction and other reactions leading to the same final nuclei. A similarity with single-neutron stripping is observed, which suggests a (^{6}Li,t) reaction mechanism involving direct transfer of a proton-pair coupled to a single neutron. The possible two-step process (^{6}Li,d)(d,t) is also suggested to account for two cases of f/sub 7/2/ hole states populated in the nickel isotopes. The ^{58}Ni(^{6}Li,t) ^{61}Zn Q value was measured to be -4736 +- 23 keV giving a mass excess of -56 352 +- 26 keV for ^{61}Zn. This mass excess is believed to be more reliable than previous measurements with other techniques that differ by 500 keV. The triton spectrum for the ^{58}Ni(^{6}Li,t)^{61}Zn reaction yields the first measurement of the energy levels of ^{61}Zn.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 36281, 36284

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, THEORETICAL

RADIOACTIVE DECAY

36285 Nuclear data sheets for A=48. Beene, J.R. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Nucl. Data Sheets;* **23**: No. 1, 1-70(Jan 1978).

Experimental data available through September 1977 have been reviewed in detail. A summary of information obtained in various reaction and decay experiments is presented, together with adopted level schemes which represent, in the compilers' judgment, the best available nuclear structure information on A=48 nuclei.

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

36286 Nuclear data sheets for A=51. Auble, R.L. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Nucl. Data Sheets;* **23**: No. 2, 163-228(Feb 1978).

Nuclear structure data available through August 1977 are compiled, and adopted level properties are given. The bulk of the data is presented pictorially for easy comparison. Experimental details, references, and additional comments, where required, are given in the text. All drawings, tables, and comments are reproduced from the computerized Evaluated Nuclear Structure Data File (ENSDF). Any additions or corrections desired by the users should be addressed to the compilers for maintenance and updating of the computer file.

36287 Giant electric resonances in ^{58}Ni studied by alpha particle capture. Meyer-Schuetzmeister, L.; Segel, R.E.; Raghunathan, K.; Debevec, P.T.; Wharton, W.R.; Rutledge, L.L.; Ophel, T.R. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., C;* **17**: No. 1, 56-65(Jan 1978).

The reaction ^{54}Fe(α,γ_0)^{58}Ni has been studied for 7.6 > or = E/sub b/MeV. Seventeen angular distributions have been measured in this energy region making it possible to separate the E2 strength from the E1 strength. The E1 cross section reaches a maximum at about the expected energy. A compact E2 resonance was observed which agrees quite well with the one measured by inelastic α scattering, with a peak cross section at about 16 MeV and a width of ~3 MeV(half width at half maximum). The observed E1 strength equals 0.9% of the isospin allowed E1 sum rule. The measured E2 strength, however, equals 4.3% of the isoscalar E2 sum rule, which is about the same as the fraction of the total E1 strength in ^{58}Ni excited by proton capture. Assuming only statistical processes and applying the Hauser-Feshbach formula to calculate the total γ absorption from the measured particle-capture cross sections leads to the conclusion that the (α,γ) reaction exciting the isoscalar giant quadrupole resonance and the (p,γ) reaction exciting the giant dipole resonance must have direct components.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 36281, 36284

36288 (COO—2696-004) **Determination of neutron cross sections and resonance parameters for vanadium, the stable thallium isotopes, and the stable tellurium isotopes. Progress report, October 1, 1976—October 31, 1977.** Winters, R.R. (Denison Univ., Granville, Ohio (USA)). Oct 1977. Contract EY-76-S-02-2696. 7p. Dep. NTIS, PC A02/MF A01.

The analysis of the neutron capture cross section data for ^{51}V + n has now been completed up to 215 keV. Using a few neutron widths and spin and parity assignments from the literature, the capture data has yielded estimates of radiative widths for 45 s-wave resonances and capture areas for 139 resonances. Of particular interest is the very large s-wave radiative widths for this reaction and the rather broad distribution of radiative widths. A paper describing these results is included with this report. The analysis of the neutron capture cross sections for the reaction ^{205}Tl(n,γ) is presently being extended to incident neutron energy 115 keV. The study of the scattered-beam sensitivity of the total energy detectors at the ORELA capture facility continues. This small but troublesome effect has now been parameterized, but the errors to be assigned to the parameterization are not yet well defined. However, in obtaining additional data for the parameterization, a series of ^{208}Pb(n,γ) cross section measurements were made. The analysis of these data led to results important in understanding stellar nucleosynthesis and are reported in a paper included with this report. the analysis of the Te(n,γ) data proceeds methodically but slowly.

36289 ^{16}O + ^{48}Ca reaction at 56 MeV. I. Transitions to resolved levels. Kovar, D.G.; Henning, W.; Zeidman, B.; Eisen, Y.; Erskine, J.R.; Fortune, H.T.; Ophel, T.R.; Sperr, P.; Vigdor, S.E. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., C;* **17**: No. 1, 83-110(Jan 1978).

All direct reaction channels of significant strength (σ > or = 50 μb) in the ^{16}O + ^{48}Ca reaction at E/sub lab/(^{16}O) = 56 MeV were measured using a Δe - E time-of-flight telescope system. Excitation spectra with energy resolutions ≅ 200 keV full width at half maximum were obtained for outgoing ions /sup 11,12,13/B, /sup 12,13,14,15/C, /sup 14,15,16,17/N, and /sup 16,17,18,19/O. Angular distributions were obtained for the strongest transitions observed in inelastic scattering, the single-nucleon transfer reactions (^{16}O, ^{15}N) and (^{16}O, ^{17}O), the two-nucleon transfer reactions (^{16}O, ^{14}C), (^{16}O, ^{14}N), and (^{16}O, ^{18}O), the three-nucleon transfer reactions (^{16}O, ^{13}C), and the "exotic" transfers (^{16}O, ^{16}N) and (^{16}O, ^{15}C). Comparison of distorted-wave Born-approximation calculations for inelastic scattering, and for one- and two-nucleon transfer reactions to experiment suggest that reaction processes more complex than the one-step process are quite important in a majority of the transitions studied.

36290 Evaporation residues from the fusion of ^{32}S with ^{58}Ni and ^{70}Ge observed with an energy-mass spectrograph. Horn, D.; Enge, H.A.; Sperduto, A.; Graue, A. (Laboratory for Nuclear Science, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev., C;* **17**: No. 1, 118-125(Jan 1978).

Evaporation residues from the fusion reactions of 110 MeV ^{32}S with ^{58}Ni and 132 MeV ^{32}S with ^{70}Ge were observed with the aid of an energy-mass spectrograph. The residues were resolved by mass number, and the masses observed in the ^{32}S + ^{58}Ni reaction were A = 84 (23% +- 5%), A = 86 (27% +- 5%), and A = 87 (50% +- 10%). The ^{32}S + ^{70}Ge reaction yielded A = 94 (14% +- 1%), A = 95 (23% +- 1%), A = 96 (14% +- 1%), A = 97 (24% +- 1%), A = 98 (21% +- 1%), and A = 99 (5% +- 1%). Angular distributions and velocity spectra were obtained for each mass, allowing partial reconstruction of the residues' kinematic history, and consequently of the particle evaporation modes leading to each residue. Average particle energies and anisotropies for each residue mass may be inferred from comparison with a Monte Carlo simulation of the evaporation process. The results are discussed and compared with calculations made with the aid of a statistical model evaporation code.

36291 ^{35}Cl-induced fission and fissionlike reactions on /sup 58,62/Ni, /sup 112,116,120,124/Sn, and ^{141}Pr. Bisplinghoff, J.; David, P.; Blann, M.; Scobel, W.; Mayer-Kuckuk, T.; Ernst, J.; Mignerey, A. (Nuclear Structure Research Laboratory, University of Rochester, Rochester, New York 14627). *Phys. Rev., C;* **17**: No. 1, 177-187(Jan 1978).

Counter telescopes (gas ΔE, Si-E) were used to measure angular distributions of binary yield products resulting from bombardment of /sup 58,62/Ni, /sup 112,116,120,124/Sn, and ^{141}Pr targets with ^{35}Cl beams at energies between 155 and 170 MeV. Results are presented for angular distributions averaged over bins two atomic numbers wide and integrated over all fragment atomic numbers. The Sn and Pr targets give yields consistent with an equilibrium fission mechanism according to charge distributions, kinetic energies, and angular distributions. The interpretation of yields from Ni targets is found to be more ambiguous. All systems give fragment energies consistent with semiempirical trend formulas, independent of asymmetry. Qualitative evidence for deep inelastic yields, in addition to fission yields, are found for Sn and Pr targets.

36292 Neutron resonance spectroscopy in vanadium, manganese, and cobalt. Garg, J.B. (State Univ. of New York, Albany). *Nucl. Sci. Eng.;* **65**: No. 1, 76-92(Jan 1978).

High-resolution total neutron cross-section measurements in natural vanadium, manganese, and cobalt were made in the energy range up to a few hundred keV with the Columbia University Nevis neutron velocity spectrometer using a 200-m flight path and a nominal resolution of 0.5 ns/m. These cross-section data were ana-

lyzed with an R-matrix multilevel code, and the resonance parameters (E/sub lambda/, GAMMA/sub n/, J/sup π/, S_0, D) were obtained. In addition, making use of the published thermal energy data, the parameters of the bound levels were determined. From these measurements the values of S_0 up to 215-keV neutron energy for vanadium, up to 200 keV for manganese, and up to 80 keV for cobalt have been obtained. The value of spin cut-off factor sigma is found to vary from 2.7 to 4 for these nuclei. These results do not show any J dependence on the strength function.

NUCLEAR PROPERTIES AND REACTIONS, A=59-89, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 36281, 36291

36293 Primary-fragment angular momenta in deep-inelastic reactions. Natowitz, J.B.; Namboodiri, M.N.; Kasiraj, P.; Eggers, R.; Adler, L.; Gonthier, P.; Cerruti, C.; Alleman, T. (Cyclotron Institute and Department of Chemistry, Texas AandM University, College Station, Texas 77840). *Phys. Rev. Lett.;* **40**: No. 12, 751-754(20 Mar 1978).

γ-ray multiplicities <M/sub γ/and energies <E/sub γ/associated with identified products of completely damped collisions of 237-MeV ^{40}Ar with ^{89}Y are analyzed to determine the angular momenta of the primary heavy fragments. Extending the analysis to the system 175-MeV ^{20}Ne + Ag allows a comparison which indicates that different partial waves contribute in these two nearly identical composite systems at almost the same excitation energy and that the transition from fusion-evaporation to deep-inelastic reactions occurs over a wide range of partial waves.

36294 Nuclear shapes at high angular momentum. Deleplanque, M.A.; Lee, I.Y.; Stephens, F.S.; Diamond, R.M.; Aleonard, M.M. (Nuclear Science Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev. Lett.;* **40**: No. 10, 629-632(6 Mar 1978).

Multiplicities as a function of γ-ray energy have been measured for continuum γ-ray spectra produced in argon- and calcium-induced reactions. A peak sometimes occurs in the multiplicity spectrum, indicating a correlation between γ-ray energy and multiplicity (spin). This correlation can be explained by rotational motion of the nucleus, suggesting basically prolate nuclear shapes. Absence of structure in the multiplicity spectrum is interpreted to indicate nocollective motion, and hence spherical or oblate shapes.

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, THEORETICAL

NUCLEAR REACTIONS AND SCATTERING

36295 Exact calculation of the penetrability for a simple two-dimensional heavy-ion fusion barrier. Kodama, T.; Nazareth, R.A.M.S.; Moeller, P.; Nix, J.R. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro, Brazil). *Phys. Rev., C;* **17**: No. 1, 111-117(Jan 1978).

In a study of the effect of the quantal zero-point oscillations of nuclei on their low-energy fusion cross section, we calculate exactly the penetrability for a simple two-dimensional barrier V (r,σ). The coordinate r is the distance between the centers of mass of the two nuclei, and σ is the sum of the root-mean-square extensions along the symmetry axis of the matter distribution of each nucleus about its center of mass. The potential V (r,σ) is a parabolic peak in r and is one or the other of two harmonic oscillators in σ, depending upon whether r is greater than or less than a critical value r_1. The oscillators differ both in the locations of their minima and in their curvatures. This simulates the dominant feature in the two-dimensional nuclear potential-energy surface of two misaligned valleys (the fission and fusion valleys) separated by a ridge between them. When an incident wave that is localized in the fusion valley encounters the potential-energy ridge, it is partially transmitted and partially reflected in waves that correspond to different excited states in the transverse direction and hence to different amounts of energy in the fusion direction. The amplitudes of these waves are determined by requiring that the wave functions (expressed exactly in terms of parabolic-cylinder functions) and their first derivatives be continuous at r_1. The penetrability is then obtained from the amplitudes of the transmitted waves. As a specific example, we use this formalism to calculate the penetrability for a two-dimensional potential-energy surface appropriate to the reaction ^{100}Mo + ^{100}Mo $\rightarrow$ ^{200}Po. The calculated penetrability is substantially different from the result for a one-dimensional calculation. In particular, 10 MeV below the maximum in the one-dimensional fusion barrier the two-dimensional penetrability is 10^{10} times as large as the one-dimensional result. Also, for equal penetrability the slopes of the two curves are very different.

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, EXPERIMENTAL

RADIOACTIVE DECAY

36296 Spectroscopy of the ^{108}In nucleus. Hseuh, H.; Macias, E.S. (Department of Chemistry, Washington University, St. Louis, Missouri 63130). *Phys. Rev., C;* **17**: No. 1, 272-279(Jan 1978).

The γ rays following the β decay of 10.30-min ^{108}Sn and from the in-beam ^{108}Cd(p,n)^{108}In* (γ) reaction between 6.5 and 10 MeV have been studied in order to determine the properties of the low-lying levels of ^{108}In. Twenty-five γ rays attributed to ^{108}Sn decay were observed. A level scheme of ^{108}In was constructed which contains nine levels, of which only three were previously reported. Spin and parity values are assigned to each level based on angular distribution and excitation function measurements from the (p,nγ) reaction and logft falues from ^{108}Sn decay. The level properties of ^{108}In are compared to the levels of ^{94}Nb and interpreted within the framework of j-j coupling.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 36294, 36296

36297 (IS—4351) Recent results from studies of non-gaseous fission products with TRISTAN II. Hill, J.C. (Ames Lab., Iowa (USA)). Mar 1978. Contract W-7405-ENG-82. 48p. Dep. NTIS, PC A03/MF A01.

A new in-beam target ion-source combination has been installed at the TRISTAN isotope separator facility. Mass separated beams of nongaseous fission products are now available for study. Studies of levels in even-even Cd and Sn nuclei populated through the decay of Ag and In fission products are described, and an evaluation of possibilities for future research is made.

36298 Nuclear data sheets for A=109. Bertrand, F.E. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Nucl. Data Sheets;* **23**: No. 2, 229-285(Feb 1978).

Adopted level schemes, level properties, and decay schemes are presented for known members of the A=109 mass chain. Adopted values are based on evaluation of experimental results contained in ≃150 papers. The present evaluation supersedes the 1971 version of A=109 (Nuclear Data Sheets B6, 1, 1971) and is based on experimental data received before October 1977.Since the 1971 evaluation, significant new results have been published for most of the A=109 nuclei. In particular, the decay scheme of ^{1}09Rh has been established, several reaction experiments have yielded level properties for ^{109}In, and firm J/sup π/assignments for ^{109}Ag and ^{109}Cd have been extended to more levels through recent reaction studies. However, measurements of the decay of ^{109}Sn to ^{109}In still contain the serious discrepancies noted in the previous A=109 evaluation.The evaluators have used footnotes throughout the compilation to point out discrepancies, uncertainties, and the lack of data. It is hoped that this evaluation will serve as the basis for further experiments and calculations which will add to the knowledge of the nuclear structure of A=109 nuclei.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 36281, 36288, 36294

36299 Evidence for angular momentum fractionation in ^{86}Kr-induced reactions on /sup 107,109/Ag, ^{165}Ho, and ^{197}Au. Aleonard, M.M.; Wozniak, G.J.; Glaessel, P.; Deleplanque, M.A.; Diamond, R.M.; Moretto, L.G.; Schmitt, R.P.; Stephens, F.S. (Nuclear Science Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Rev. Lett.;* **40**: No. 10, 622-625(6 Mar 1978).

γ-ray multiplicities have been measured as a function of the light-fragment atomic number Z_3 for the above reactions. The failure of the measured γ multiplicities for deep-inelastic collisions to rise with decreasing Z_3, according to the rigid-rotation limit, appears more likely to be associated with a selective population of the low-Z fragments by the lower-l waves rather than with an incomplete relaxation of the rotational energy.

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

36300 Double crossing of the ground rotational band and super band. Peker, L.K.; Hamilton, J.H. (Natuurkundig Laboratorium der Vrije Universiteit, Amsterdam, Netherlands). *Phys. Rev. Lett.;* **40**: No. 12, 744-748(20 Mar 1978).

We suggest that the crossing of the ground rotational band by a second rotational-aligned band may in fact be a double crossing. From extrapolations of the rotational energy formula, we show that one could expect such a second crossing around I ≅ 30 in ^{158}Er. This provides an alternative explanation in terms of a double band crossing for the second discontinuity recently observed in the moment of inertia about I = 28 in ^{158}Er.

MOMENTS AND SPIN

REFER ALSO TO CITATION(S) 36300

NUCLEAR PROPERTIES AND REACTIONS, A=150-189, EXPERIMENTAL

RADIOACTIVE DECAY

REFER ALSO TO CITATION(S) 36302

ENERGY LEVELS AND TRANSITIONS

36301 (p, t) reaction as a probe for the structure of odd-odd nuclei: Levels in ^{174}Lu. Struble, G.L.; Lanier, R.G.; Mann, L.G.; Kouzes, R.T.; Mueller, D.; Naumann, R.A.; Girshick, F.; Oelrich, I.C.; Moore, W.H. (University of California, Lawrence Livermore Laboratory, Nuclear Chemistry Division, Livermore, California 94550). *Phys. Rev. Lett.;* **40**: No. 10, 615-618(6 Mar 1978).

The (p, t) reaction is employed for the first time to study the structure of the deformed, rare-earth, odd-odd nucleus, ^{174}Lu. In addition to a number of level that have been characterized in previous studies, we have seen the rotational band built on the [π7/2 + (404), ν7/2 - (514)]/sub K7 configuration. This band is about 6% admixed with the [π7/2 + (404), ν5/2 - (512)]/sub K6 band. In addition, we have observed intensity resulting from four-quasiparticle configurations related to the ground states of both ^{176}Lu and ^{174}Lu.

36302 Decay scheme studies of neutron deficient erbium isotopes and their daughters. Anderson, D.L. Worcester, MA; Clark Univ. (1977). 224p. University Microfilms Order No. 77-23,416.

Thesis (Ph. D.).

The decays of several erbium and holmium isotopes were studied following the production of sources by ^{149}Sm(^{12}C,xn)/sup 161-x/Er reactions at the Yale University HILAC and the Lawrence Berkeley and Livermore Laboratory 88 in. cyclotron. Ge(Li) γ-ray singles spectra were measured at Yale and at the Lawrence Livermore Laboratories. Some of the California γ-ray singles spectra were taken employing sources separated by high pressure ion-exchange chromatography. γ-γ coincidence measurements were also made. Ten energy levels are proposed in ^{157}Ho. The level scheme for ^{157}Dy was found to be in general agreement with the work of Torres, Paris, and Kilcher. There is some evidence that the negative parity level at 688.0 keV is a member of a K = 0 β-vibrational band built on the $^3/_2^-$ ground state. Over 20 new levels are proposed in the level scheme of ^{158}Dy, including the 2^+, 3^+, 4^+, 5^+, and 6^+ members of a rotational band, the 2^-, 3^-, 4^-, and 5^- members of a K/sup π/ = 1^- octupole vibrational band, and the 1^- and 3^- members of a K/sup π/ = 0^- octupole vibrational band. Several other new levels are proposed and discussed. The results for ^{158}Dy are compared to the level structures of the other even-mass dysprosium isotopes. Levels in ^{158}Ho are found in agreement with previous work. One new level of unknown I/sup π/ is proposed at 1210.4 keV. Tentative two-neutron Nilsson configuration assignments are proposed for these levels based on the level structures of ^{157}Ho and ^{157}Dy.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 36299

36303 Reactions of ^{20}Ne on ^{150}Nd at 175 MeV. Halbert, M.L.; Dayras, R.A.; Ferguson, R.L.; Plasil, F.; Sarantites, D.G. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* **17**: No. 1, 155-162(Jan 1978).

Energy spectra of charged-particle reaction products from bombardment of ^{150}Nd by 175-MeV ^{20}Ne were measured with three ΔE,E telescopes at angles from 3.5° to 100°. The evaporation residues and symmetric-fission fragments were easily identified; their total cross sections were 1150 +- 90 and 280 +- 35 mb, respectively. The sum of these numbers is in good agreement with the fusion cross section predicted by the Bass model. The elastic cross section drops to 1/4 of the Rutherford cross section at 30.4 +- 0.2° (lab), which implies that the total reaction cross section is 2.63 b. Products from quasielastic and from strongly damped collisions were observed; their angle-integrated yields account for the balance of the reaction cross section.

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, EXPERIMENTAL

RADIOACTIVE DECAY

36304 Nuclear data sheets for A=205. Schmorak, M.R. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Nucl. Data Sheets;* **23**: No. 2, 287-352(Feb 1978).

The available experimental data pertaining to the nuclear structure of nuclei with A=205 are compiled; the results from various decay and reaction measurements are compared and evaluated. Inconsistencies and discrepancies in the level schemes are discussed. The values of r_0 parameter, used to calculate α HF, were obtained as in 72ElSc.

ENERGY LEVELS AND TRANSITIONS

36305 γ-ray and internal-conversion intensity studies of transitions in the decay of ^{228}Th. Avignone, F.T. III; Schmidt, A.G. (University of South Carolina, Columbia, South Carolina 29208). *Phys. Rev., C;* **17**: No. 1, 380-384(Jan 1978).

High resolution intensity studies have been made of the 115, 239, and 300 keV transitions in ^{212}Bi, the 252, 277, 511, 583, 722, 763, and 860 keV transitions in ^{208}Pb, the 288, and 453 keV transitions in ^{208}Tl, and the 727 and 785 keV transitions in ^{212}Po, using carefully intensity-calibrated Ge(Li) and Si(Li) detectors. Twenty-four K-, L-, and M-shell internal-conversion coefficients were derived from the data and multipole mixing parameters vertical-bar δ vertical-bar and mixing percentages were deduced.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 36281, 36288

36306 Neutron scattering and the optical model near A = 208 and implications on the inelastic scattering cross section of uranium-238. Guenther, P.T.; Havel, D.G.; Smith, A.B. (Argonne National Lab., IL). *Nucl. Sci. Eng.;* **65**: No. 1, 174-180(Jan 1978).

Differential elastic neutron scattering cross sections of ^{206}Pb, ^{207}Pb, ^{208}Pb, and ^{209}Bi are measured at incident neutron energy intervals of approximately 25 keV from 0.6 to 1.0 MeV. Optical model parameters are obtained from the energy-averaged experimental results for each of the isotopes. The ^{209}Bi model was selected for extrapolation to ^{238}U by introducing a small (N - Z)/A dependence and the known deformation of ^{238}U. Calculated results are descriptive of ^{238}U total neutron cross sections from a few hundred keV to greater than 15.0 MeV and of recently measured differential ^{238}U elastic and inelastic neutron scattering distributions at energies of less than or approximately equal 3.0 MeV, including new experimental values explicitly obtained for these comparisons. The model and the measurements imply total ^{238}U inelastic neutron scattering cross sections considerably larger than in common applied usage.

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, THEORETICAL

RADIOACTIVE DECAY

36307 Nuclear data sheets for A=237. Ellis, Y.A. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Nucl. Data Sheets;* **23**: No. 1, 71-121(Jan 1978).

The available nuclear structure information for all nuclei with mass number A=237 is presented. Various decay and reaction data are evaluated and compared. Adopted data, levels, spin parity, and configuration assignments are given.

36308 Nuclear data sheets for A=241. Ellis, Y.A. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Nucl. Data Sheets;* **23**: No. 1, 123-161(Jan 1978).

The available nuclear structure information for all nuclei with mass number A=241 is presented. Various decay and reaction data are evaluated and compared. Adopted data, levels, spin, parity, and configuration assignments are given.

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 36300

36309 Electron scattering from the octupole band in ^{238}U. Hirsch, A.; Creswell, C.; Bertozzi, W.; Heisenberg, J.; Hynes, M.V.; Kowalski, S.; Miska, H.; Norum, B.; Rad, F.N.; Sargent, C.P.; Sasanuma, T.; Turchinetz, W. (Department of Physics and Laboratory for Nuclear Science, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev. Lett.;* **40**: No. 10, 632-634(6 Mar 1978).

A simple model for nuclear surface vibrations in permanently deformed nuclei does well in reproducing electron scattering cross sections of rotational levels built on a K/sup π/= 0^- intrinsic octupole vibration in ^{238}U.

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 36306, 36309

SPONTANEOUS AND INDUCED FISSION

36310 Evaluation of ENDF/B-IV and Hansen—Roach ^{233}U cross sections for use in criticality calculations. McNeany, S.R.; Jenkins, J.D. (Oak Ridge National Lab., TN). *Nucl. Sci. Eng.;* **65**: No. 3, 441-453(Mar 1978).

Eleven ^{233}U solution critical assemblies spanning an H/^{233}U ratio range of 40 to 2000 and an unreflected metal ^{233}U assembly were calculated with ENDF/B-IV and Hansen—Roach cross sections. Results from these calculations are compared with the experimental results and with each other. An increasing disagreement is observed between calculations with ENDF/B and Hansen—Roach data with decreasing H/^{233}U ratio, indicative of large differences in their intermediate-energy cross sections. The Hansen—Roach cross sections appeared to give reasonably good agreement with experiments over the whole range, whereas the ENDF/B calculations yielded high values for k/sub eff/ on assemblies of low moderation. It is concluded that serious problems exist in the ENDF/B-IV representation of the ^{233}U cross sections in the intermediate energy range and that further evaluation of this nuclide is warranted. In addition, it is recommended that an experimental program be undertaken to obtain ^{233}U criticality data at low H/^{233}U ratios for verification of generalized criticality safety guidelines. 3 figures, 15 tables.

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

REFER ALSO TO CITATION(S) 36309

NUCLEAR REACTIONS AND SCATTERING

REFER ALSO TO CITATION(S) 36281

36311 Use of interactive graphic techniques to evaluate uranium-238 cross sections from integral measurements. Parvez, A.; Becker, M. (Rensselaer Polytechnic Inst., Troy, NY). *Nucl. Sci. Eng.;* **65**: No. 2, 354-367(Feb 1978).

An interactive graphic technique has been developed to analyze and interpret integral measurements. The method has been employed to carry out sensitivity studies and interactive data adjustments to the Rensselaer Polytechnic Institute flux measurements in an assembly of uranium depleted in ^{235}U isotope. Adjustments (relative to ENDF/B-IV) in the total inelastic cross section and the secondary distribution are reported.

36312 Differential neutron scattering cross sections of uranium-238 at 144 keV. Tsang, F.Y.; Brugger, R.M. (Univ. of Missouri, Columbia). *Nucl. Sci. Eng.;* **65**: No. 1, 70-75(Jan 1978).

The differential elastic and inelastic neutron scattering cross sections of ^{238}U at 144 keV were measured using a silicon neutron filtered beam and a spherical proton recoil counter. The absolute magnitudes were obtained by comparison with the measured lead cross section. Both integrated values show excellent agreement with the ENDF/B-IV file.

SPONTANEOUS AND INDUCED FISSION

36313 Neutron capture and fission cross sections of ^{241}Pu. Weston, L.W.; Todd, J.H. (Oak Ridge National Lab., TN). *Nucl. Sci. Eng.;* **65**: No. 3, 454-463(Mar 1978).

Neutron capture and fission cross sections of ^{241}Pu were measured from 0.01 eV to 30 keV, and their ratio was measured up to 250 keV. The cross sections were normalized at thermal-neutron energies (0.02 to 0.03 eV) to the ENDF/B-IV evaluation. The source of pulsed neutrons was the Oak Ridge Electron Linear Accelerator. The gamma-ray detector used to detect capture and fission events was the "total energy detector," which is a low-efficiency detector whose average efficiency is forced to be proportional to the energy of the interacting gamma rays by weighting these events according to their pulse height in the scintillator. Fast-neutron scintillation detectors with pulse-shape discrimination were used to detect fission events. The shape of the neutron flux was measured relative to the ^{10}B(n,α) cross section. The measurements are unique for ^{241}Pu in that absorption and fission were determined directly and simultaneously over a wide neutron energy range rather than indirectly by inferring capture from separate fission and total cross-section measurements. The results indicate that the neutron resonance region of the ENDF/B-IV evaluation underestimates capture by a factor of approximately 2. Above the resonance region (approximately 100 eV), there are no previous measurements of the differential capture cross section. These cross sections are important in plutonium-fueled reactors. 6 figures, 4 tables.

36314 Predictions of fission cross sections in the 3- to 5-MeV neutron energy range. Behrens, J.W.; Howerton, R.J. (Univ. of California, Livermore). *Nucl. Sci. Eng.;* **65**: No. 3, 464-467(Mar 1978).

Predicted fission cross-section values, based on systematic trends observed recently by Behrens, are presented in the neutron energy interval from 3 to 5 MeV for 43 isotopes, ranging from thorium through californium. Comparisons with measured fission cross-section values are included for 33 isotopes. 1 figure, 2 tables.

36315 Mass distributions in monoenergetic-neutron-induced fission of ^{238}U. Nagy, S.; Flynn, K.F.; Gindler, J.E.; Meadows, J.W.; Glendenin, L.E. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., C;* **17**: No. 1, 163-171(Jan 1978).

Fission product yields for 44 masses were determined for the fission of ^{238}U with essentially monoenergetic neutrons of 1.5, 2.0, 3.9, 5.5, 6.9, and 7.7 MeV. Fission product activities were measured by Ge(Li) γ-ray spectrometry of irradiated ^{238}U foils and by chemical separation of the fission product elements followed by β counting and/or γ-ray spectrometry. The mass-yield data for ^{238}U(n,f) show clearly the sensitive exponential increase of fission yields in the near-symmetric mass region (valley) with increasing incident neutron energy E/sub n/ (peak-to-valley ratio decreasing from $\sim$600 to $\sim$40) over the range E/sub n/ = 1.5 to 7.7 MeV with little change in yields in other regions of the mass distribution. The valley yields plotted semilogarithmically as a function of E/sub n/ reveal an abrupt change in slope at the onset of second-chance fission just above the neutron binding energy (at $\sim$6 MeV) where the excitation energy is lowered by competition with neutron evaporation prior to fission. Systematics are developed to permit synthesis of the mass distribution for any neutron energy in the range of 1.5 to 18 MeV.

36316 Prompt neutrons from neutron-induced fission of ^{237}Np. Veeser, L.R. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *Phys. Rev., C;* **17**: No. 1, 385-387(Jan 1978).

The average number of prompt neutrons per fission has been measured for ^{237}Np using a scintillator tank that has a neutron detection efficiency of about 70%. The measurements at six energies between 1.0 and 14.7 MeV have an accuracy of +- 2%. A least squares fit to the results gives nu-bar/sub p/ = 2.605 + 0.153E/sub n/ (MeV).

36317 Fission cross section for curium-245 from 0.01 to 35 eV. Browne, J.C. (Univ. of California, Livermore); Benjamin, R.W.; Karraker, D.G. *Nucl. Sci. Eng.;* **65**: No. 1, 166-170(Jan 1978).

The differential neutron-induced fission cross section of ^{245}Cm was measured from 0.01 to 35 eV at the Lawrence Livermore Laboratory 100-MeV electron Linac using approximately 6 μg of ^{245}Cm. The energy dependence of the cross section is non-1/v below 1 eV due mainly to a bound level. Normalizing to previous integral data, a thermal (2200 m/s) fission cross section of 2143 +- 58 b is obtained. Resonance parameters were extracted and are compared to previous results. Calculated values of the resonance integrals for fission and capture using these parameters are in good agreement with previous measurements.

36318 Fission cross sections of uranium-234 and uranium-236 relative to uranium-235. Meadows, J.W. (Argonne National Lab., IL). *Nucl. Sci. Eng.;* **65**: No. 1, 171-174(Jan 1978).

Fission cross-section ratio measurements were made in the 2- to 3-MeV region using ^{235}U samples with ^{234}U and ^{236}U samples containing approximately 10% ^{235}U. Atom ratios were obtained from measured thermal fission ratios and the isotopic analysis and also by alpha counting. Shape measurements were made from threshold to 10 MeV using pure samples and were normalized in the 2- to 3-MeV region. The present values for the ^{234}U : ^{235}U ratio are up to 5% greater than those previously reported. The results for ^{236}U

generally agree with those in the literature except for the values reported by Stein et al., which are also lower.

NUCLEAR THEORY

NUCLEAR STRUCTURE

36319 Long-range components of the effective nucleon-nucleon interaction. Moszkowski, S.A.; Needelman, D.; Golin, M. (University of California, Los Angeles, California 90024). *Phys. Rev., C;* **17**: No. 1, 297-302(Jan 1978).

We discuss two simple effective interactions which fit selected empirical (j²)/sub T/ matrix elements. One important property of both interactions is the presence of a long range repulsion in odd states, as was already pointed out previously by others. We then discuss the role of configuration mixing in both the weak coupling and strong coupling limits to show qualitatively that the repulson can arise naturally from truncation of the model space used to define the interaction. Presumably with a sufficiently larger model space no long range repulsion is needed. We also remark on the difference between yrast state energies and centroids of the single particle transfer strength. It is the latter which are based in the empirical matrix elements. Finally we briefly discuss a semiclassical model for calculating matrix elements for a finite range interaction.

36320 Rotating toroidal nuclei. Wong, C. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., C;* **17**: No. 1, 331-340(Jan 1978).

For very rapidly rotating nuclei, the moment of inertia can be readily increased if the mass is distributed in the form of a torus. Thus, a rotating toroid can be a figure of equilibrium when the angular momentum exceeds a certain limit. The angular momentum thresholds for the onset of toroidal figures of equilibrium are evaluated and found to be greater than the limits at which the fission barriers vanish for nuclei with the topology of a sphere. Stability against sausage deformation, in which the toroid becomes thicker in some sections but thinner in some other, is examined. We obtain two different results on the question of stability, depending on the flow pattern in the presence of these axially asymmetric deformations which, in turn, is greatly affected by the dissipative mechanism.

NUCLEAR MATTER

36321 Axial currents in nuclei. Kubodera, K.; Delorme, J.; Rho, M. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev. Lett.;* **40**: No. 12, 755-758(20 Mar 1978).

It is shown that the time component of axial currents in nuclei can be given a simple description in terms of a one-pion exchange diagram with its structure constrained by a soft-pion theorem. We suggest the directional correlation mesurements in nuclear β decay as a possible means to test the theory.

NUCLEAR REACTIONS AND SCATTERING

36322 Restrained acceleration in iteration. Vondy, D.R.; Fowler, T.B. (Oak Ridge National Lab., TN). *Nucl. Sci. Eng.;* **65**: No. 2, 415-416(Feb 1978).

A procedure is described that is used to restrain the iterate estimates of a dependent variable (such as the local neutron flux) when acceleration is applied. This scheme allows negative values but prevents extrapolation from positive values to a negative result.

36323 Determination of internuclear potentials from heavy-ion fusion excitation functions. Birkelund, J.R.; Huizenga, J.R. (Departments of Chemistry and Physics and Nuclear Structure Research Laboratory, University of Rochester, Rochester, New York 14627). *Phys. Rev., C;* **17**: No. 1, 126-130(Jan 1978).

The internuclear potential determined from published fusion barrier parameters is compared with the proximity potential of Blocki et al. Discussion is given of the uncertainties introduced into the data analysis by the effects of friction and errors in the barrier radii.

36324 Deep inelastic pion-induced nuclear reactions in the isobar model. Ginocchio, J.N. (Theoretical Division, Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87545). *Phys. Rev., C;* **17**: No. 1, 195-214(Jan 1978).

Deep inelastic pion-induced nuclear reactions are calculated in the isobar model, which assumes that an interacting resonant pion and nucleon form an unstable particle, the Δ, which can propagate through the nucleus and either decay or be absorbed by interacting with other nucleons in the nucleus. The propagation of the particles is treated classically and the interactions are assumed to be incoherent. The lifetime of the Δ is taken to be energy dependent as prescribed by measured pion-nucleon scattering and the cross section of the Δ absorption is determined by measured pion production in two nucleon collisions. The formation of the Δ by a pion and nucleon and the subsequent absorption of the Δ provide a two-step mechanism for pion absorption. These calculations indicate that the pion is absorbed mostly on the inside forward edge of the nuclear surface where the nuclear density has almost reached central density. The calculations are compared with measured pion absorption cross scetions, proton spectra, and spallation products in pion-induced reactions. All of these data indicate that pion absorption is underestimated in this model by perhaps as much as 35%, particularly for low energy (~100 MeV) pions. Possible explanations for these discrepancies are discussed.

RADIATION AND SHIELDING PHYSICS

RADIATION PHYSICS

REFER ALSO TO CITATION(S) 36334

36325 (BNL—50730) **Relative determination of W-values for alpha particles in tissue equivalent and other gases.** Krieger, G.L. (Brookhaven National Lab., Upton, N.Y. (USA)). Jun 1976. Contract EY-76-C-02-0016. 38p. Dep. NTIS, PC A03/MF A01.

W (the average energy to form an ion pair) for 5.4 MeV ^{241}Am alpha particles in a Rossi-type tissue equivalent (T.E.) gas, argon and methane was determined to an accuracy better than 0.2% using a new automated data handling system. A vibrating reed electrometer and current digitizer were used to measure the current produced by completely stopping the alpha particles in a large cylindrical ionization chamber. A multichannel analyzer, operating in a slow multiscalar mode, was used to store pulses from the current digitizer. The dwell time, on the order of 60 minutes per channel, was selected with an external timer gate. Current measurements were made at reduced pressures (approximately 200 torr) to reduce ion-recombination. The average current, over many repeated measurements, was compared to the current produced in nitrogen and its previously published W-value of 36.39 +- 0.04 eV/ion pair. The resulting W-values were (in eV/ion pair): 26.29 +- 0.05 for argon, 29.08 +- 0.03 for methane and 30.72 +- 0.04 for T.E. gas, which had an analyzed composition of 64.6% methane, 32.4% CO_2, and 2.7% nitrogen. Although the methane and argon values agree within 0.1% with previously published values, the value for T.E. is 1.2% lower than the single previously reported value.

36326 Electromagnetic showers at high energy. Loos, J.S.; Dawson, S.L. (Physics Department, Duke University, Durham, North Carolina 27706). *Am. J. Phys.;* **46**: No. 5, 560-564(May 1978).

Electromagnetic showers induced by 1.57-GeV e^+ particles incident on a tantalum plate have been studied in a bubble chamber experiment. These showers illustrate many of the interesting properties of bremsstrahlung, e^+e^- pair production, Compton scattering, and other quantum phenomena. Some detailed comparisons between experiment and theory are made by using computer-generated simulations of electromagnetic showers.

36327 Energy deposition by fast protons in pellet fusion targets. Nardi, E.; Peleg, E.; Zinamon, Z. (Weizmann Institute of Science, Rehovot, Israel). *Phys. Fluids;* **21**: No. 4, 574-579(Apr 1978).

The energy loss of energetic protons in heavy metal targets is calculated at temperatures and densities of interest for pellet fusion. The contributions of bound and free electrons to the stopping power are considered. It is found that in the temperature range of interest the increase in the number of free electrons in the target plasma causes range shortening with increasing temperatures and specific volumes. In order to study this effect on the ablation process, a one-dimensional calculation of the hydrodynamic flow with energy deposition was carried out.

36328 Application of the fictitious scattering radiation transport model for deep-penetration Monte Carlo calculations. Cramer, S.N. (Oak Ridge National Lab., TN). *Nucl. Sci. Eng.;* **65**: No. 2, 237-253(Feb 1978).

The fictitious scattering radiation transport model, suitable for Monte Carlo applications in geometrically complex systems, has been extended for use in deep-penetration calculations by the development of an appropriate next-flight estimator. Mathematical derivations are given, and it is shown that the estimation scheme is actually a one-dimensional version of the general model. Sample problems are solved to illustrate the use of the next-flight estimator, its variance characteristics, and the time-saving features of the model. Other items discussed are coupling techniques with standard methods, systems with large cross sections, and inclusion of the fictitious scattering model in multigroup cross-section structure.

NEUTRON INTERACTIONS WITH MATTER

REFER ALSO TO CITATION(S) 35148, 35623

36329 (ANL—7416(Suppl.2)) **Argonne Code Center: benchmark problem book.** (American Nuclear Society, La Grange Park, Ill. Computational Benchmark Problems Committee). Jun 1977. Contract W-31-109-ENG-38. 369p. Dep. NTIS, PC A16/MF A01.

This report is a supplement to the original report, published in 1968, as revised. The Benchmark Problem Book is intended to serve as a source book of solutions to mathematically well-defined problems for which either analytical or very accurate approximate solutions are known. This supplement contains problems in eight new areas: two-dimensional (R-z) reactor model; multidimensional (Hex-z) HTGR model; PWR thermal hydraulics--flow between two channels with different heat fluxes; multidimensional (x-y-z) LWR model; neutron transport in a cylindrical "black" rod; neutron transport in a BWR rod bundle; multidimensional (x-y-z) BWR model; and neutronic depletion benchmark problems. This supplement contains only the additional pages and those requiring modification. (RWR)

36330 (CONF-771109—82) **Measurement and resonance analysis of neutron transmissions through four samples of ^{238}U.** Olsen, D.K.; de Saussure, G.; Perez, R.B.; Difilippo, F.C.; Ingle, R.W. (Oak Ridge National Lab., Tenn. (USA)). 1977. Contract W-7405-ENG-26. 7p. Dep. NTIS, PC A02/MF A01.

From ANS winter meeting; San Francisco, CA, USA (27 Nov 1977).

Accurate total and partial cross sections for ^{238}U are important for nuclear reactor design. In the resolved resonance region, energies below 4.0 keV, these cross sections are described in terms of individual resonance parameters of which the neutron widths in the 1.5 to 4.0 keV region from various workers appear discrepant. In order to determine these widths, (0.880 to 100.0 keV) neutron transmissions through 0.076, 0.254, 1.080, and 3.620 cm thick enriched ^{238}U samples were measured, and (0.880 to 100.0 keV) range transmissions were analyzed. (GHT)

36331 **Effects of isotopic abundance on kerma in naturally occurring targets: chloride.** Spergel, M.S. (City Univ. of New York, Jamaica); Lazareth, O.W. *Nucl. Sci. Eng.;* **65**: No. 3, 558-560(Mar 1978).

To calculate the neutron kinetic energy release parameters (kerma factors) for an element consisting of several isotopes, it is necessary to use separate neutron cross-section and radioactive decay data for each isotope. In the case of chlorine, cross sections for natural chlorine are available, but cross sections for the individual isotopes are not. Kerma factors for chlorine were calculated using natural chlorine cross sections and weighting the contribution of each isotope to the decay data, by using the fractional contribution as a variable parameter. The kerma factors calculated at particular neutron energies are found to be sensitive to this parameter and dependent on that energy. The purpose of this Note is to encourage experimental determination of the relevant neutron cross sections of isotopically pure samples of chlorine. 2 figures, 3 tables.

36332 **Generalized rebalance: a common framework for transport acceleration methods.** Miller, W.F. Jr. (Los Alamos Scientific Lab., NM). *Nucl. Sci. Eng.;* **65**: No. 2, 226-236(Feb 1978).

Using slab geometry, generalized rebalance is presented as a class of iteration acceleration schemes applicable to the neutron transport equation. It is demonstrated that the diffusion-synthetic, variable-Eddington-factor, and conventional-rebalance schemes can be shown to be special cases of generalized rebalance. Expressing these schemes within the generalized-rebalance framework leads one to consider a new scheme labeled third-moment rebalance. Numerical results are presented that indicate that Alcouffe's diffusion-synthetic schemes are presently the best available methods.

36333 **Prediction of Monte Carlo errors by a theory generalized to treat track-length estimators.** Booth, T.E. (Los Alamos Scientific Lab., NM); Amster, H.J. *Nucl. Sci. Eng.;* **65**: No. 2, 273-281(Feb 1978).

Present theories for predicting expected Monte Carlo errors in neutron transport calculations apply to estimates of flux-weighted integrals sampled directly by scoring individual collisions. To treat track-length estimators, the recent theory of Amster and Djomehri is generalized to allow the score distribution functions to depend on the coordinates of two successive collisions. It has long been known that the expected track length in a region of phase space equals the expected flux integrated over that region, but that the expected statistical error of the Monte Carlo estimate of the track length is different from that of the flux integral obtained by sampling the sum of the reciprocals of the cross sections for all collisions in the region. These conclusions are shown to be implied by the generalized theory, which provides explicit equations for the expected values and errors of both types of estimators. Sampling expected contributions to the track-length estimator is also treated. Other general properties of the errors for both estimators are derived from the equations and physically interpreted. The actual values of these errors are then obtained and interpreted for a simple specific example.

36334 **Calculation of neutron and gamma-ray energy spectra in liquid air and liquid nitrogen due to 14-MeV neutron and californium-252 sources.** Straker, E.A.; Gritzner, M.L.; Harris, L. Jr. (Science Applications, Inc., La Jolla, CA). *Nucl. Sci. Eng.;* **65**: No. 2, 303-315(Feb 1978).

Calculations of neutron and gamma-ray fluences from 14-MeV neutron and ^{252}Cf sources in liquid air and liquid nitrogen have been performed. These calculations were made specifically for comparison with experimental data measured at Stohl, Federal Republic of Germany. The discrete-ordinates method was utilized with neutron and gamma-ray cross sections from ENDF/B-IV. One-dimensional calculational models were developed for the sources and tank. Limited comparisons are made with experimental data.

36335 **Threshold-foil measurements of reactor neutron spectra for radiation damage applications.** Verbinski, V.V.; Lurie, N.A.; Rogers, V.C. (IRT Corp., San Diego, CA). *Nucl. Sci. Eng.;* **65**: No. 2, 316-330(Feb 1978).

The accuracy of unfolding neutron spectra with threshold activation foils was investigated by comparing the unfolded spectra with "known" spectra obtained from calculations verified with more accurate spectrometry techniques. Because of the lack of spectral data below 1 MeV (only one useful activation threshold exists between 0.01 and 1 MeV), reliable results are generally obtained only with the a priori constraint of a physically complete trial spectrum. A family of trial spectra useful for reactor spectra [and any nuclear "evaporation" spectra, such as from high-energy (γ,n) reactions] has been formulated. The sensitivity of the solution phi(E) to the specific unfolding code used, to the threshold-foil cross sections and related nuclear data, and to foil-activation measurement accuracy was also investigated.

MEDICAL PHYSICS

DOSIMETRY

36336 **Planning of combined external irradiation and internal contamination to reduce dose in nuclear power plant operations.** Wijker, H.; Kema, N.V. pp 451-454 of Proceedings of the 4. International congress of the International Radiation Protection Association. Paris, 24-30 April 1977. Vol. 1. Fontenay-aux-Roses, France; Association Internationale de Protection contre les Rayonnements (1977).

From 4. congress of the International Radiation Protection Agency; Paris, France (24 Apr 1977).

See CONF-770409—.

In nuclear power plants many operations have to be carried out in high radiation fields under cramped working conditions. By omitting the hampering wearing of protective breathing apparatus, work can be speeded up and doses from external irradiation reduced. However, a dose from internal contamination is added. If this is accepted in dose planning as a tool to reduce total dose, a practical system has to be derived. A system worked out by Jacobi (1974) can be used as a base to serve this purpose. For each organ, the dose is multiplied by a special factor f to obtain a reduced dose giving the same risk as this dose from a uniform total body irradiation. Reduced-dose reserves can be introduced for planning purposes. After description of such a dose planning system, the dose reduction factors f are discussed. Instead of basing them solely on hurt-of-suffering risks as done in ICRP-publ. 13 and by Jacobi, also the differences in latent and risk periods for leukemia and other cancers are introduced for young radiological workers as well as the shortening of risk periods by life expectancy when considering yearly maximum permissible doses from 18 till 65 years of age. Systems of values of f derived from risks published in ICRP-publ. 13 (1966), UNSCEAR-report 1972, BEIR-report (1972) and by Jacobi (1974) are compared.

SOLID STATE PHYSICS

REFER ALSO TO CITATION(S) 35541, 35676

36337 (LBL—6016, pp 127-169) **Solid state physics.** 1976.

In Materials and Molecular Research Division annual report, 1976.

Experimental solid state physics research activities during 1976 at Lawrence Berkeley Laboratory are described. Topics covered include: far infrared spectroscopy; experimental solid state physics and quantum electronics; research on superconductors and superconducting devices; and excited quantum fluids in solids.

36338 (LBL—6016, pp 270-289) **Energy transfer processes in organic solids.** Harris, C.B. 1976.

In Materials and Molecular Research Division annual report, 1976.

Research activities in energy transfer processes in organic solids at Lawrence Berkeley Laboratory during 1976 are described. Topics covered include the spectroscopy of molecules absorbed on metal surfaces; energy transfer processes in molecular solids; coherent spectroscopy in excited triplet states; thermal modulation spectroscopy; and picosecond spectroscopy. (GHT)

36339 (SAND—77-2094) **Small-polaron model of light atom diffusion.** Emin, D. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1977. Contract EY-76-C-04-0789. 14p. Dep. NTIS, PC A02/MF A01.

A number of researchers have treated the diffusion of light interstitials in metals in strict analogy with the theory for the hopping diffusion of electrons in low-mobility insulators. In other words, these authors view the diffusion of light atoms as simply being an example of small-polaron hopping motion. In this paper the motion of a small polaron is introduced, and the mechanism of its motion is described. The experimental results are then succinctly presented. Next the physical assumptions implicit in the theory are compared with the situation which is believed to characterize the existence and motion of light interstitial atoms in metals. Concomitantly, the modifications of the small-polaron theory required in applying it to light atom diffusion are ennumerated.

36340 (SAND—78-0165) **Nature of interstitially induced lattice strains.** Emin, D. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1978. Contract EY-76-C-04-0789. 11p. Dep. NTIS, PC A02/MF A01.

The addition of interstitial atoms to a metal lattice has been likened to the addition of extra billiard balls to an array of tangentially touching billiard balls. In such a picture the increased clustering of interstitials can lead to the buildup of larger and larger strain fields which ultimately are associated with the production of broken bonds. Simple models of the strain fields associated with the addition of particles to a lattice in which the force exerted between the added atoms and host atoms is finite have been studied. From these studies one can define situations in which the billiard-ball approach has qualitative validity and those in which it is inappropriate. Basically, those situations in which the displacements of the host atoms can be represented as involving acoustic phonons yield long-range strain fields analogous to those of the billiard-ball model with the radius of the extra billiard ball being determined by the stiffness of the host lattice and the forces between the added atom and the surrounding host atoms. If the displacements produced by the added atoms are represented as involving primarily optical phonons the displacement pattern is short-ranged and not described by the usual elasticity theory. For example, Vegard's law does not apply in these instances. Such concerns arise in considering the strains induced by interstitial helium in tritides.

36341 **Low temperature spin wave dynamics in classical Heisenberg chains.** Heller, P.; Blume, M. (Department of Physics, Brandeis University, Waltham, Massachusetts 02154). *J. Appl. Phys.;* **49**: No. 3, 1331-1333(Mar 1978).

A detailed and quantitative study of the low-temperature spin-wave dynamics has been made for the classical Heisenberg-coupled chain using computer simulation. Results for the spin-wave frequencies are presented and compared with existing predictions.

36342 **Canonical transform theory of spin-waves in strongly anisotropic magnets.** Cooke, J.F.; Lindgard, P. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *J. Appl. Phys.;* **49**: No. 3, 2136-2138(Mar 1978).

We have developed a new infinite-order perturbation approach for treating strongly anisotropic magnets. This formalism is based on a canonical transformation of a given system into a new system with an effective two-ion anisotropy which, for example, can be treated by conventional spin-wave techniques. An expression for the spin-wave energy for the general conical magnetic moment configuration with arbitrary single-ion anisotropy has been derived using this formalism. It was found that an analysis of the transverse spin-wave spectra can at most result in a determination of a renormalized exchange integral and two renormalized anisotropy constants. A comparison of the theoretical predictions of this formalism with experimentally determined spin-wave spectra indicate that a substantial part of the large two-ion anisotropy, which had been previously introduced to describe the spin-wave spectra in the heavy rare earth series, actually resulted from the fitting procedure which was used and not from any physical source.

36343 **Probabilistic approach to polycrystalline plasticity. I. Theory.** Sackett, S.J. (Univ. of California, Livermore); Kelly, J.M.; Gillis, P.P. *J. Franklin Inst.;* **304**: No. 1, 33-46(Jul 1977).

A set of constitutive equations for polycrystalline plasticity is derived using arguments based directly on the dislocation processes involved. Distributed glide-plane orientations and Burgers-vector directions facilitate handling of the polycrystalline structure, and they yield equations involving probability distributions for variables that are directly related to measurable dislocation quantities. When the motion of the dislocations is isochoric, the tensorial character of the plastic strain rate is shown to be entirely determined by a second-rank symmetric tensor directly related to ordinary elements of crystallographic glide. This same tensor is also shown to determine the resolved shear stress acting on a dislocation in the direction of its Burgers vector, a quantity critical to the determination of the dislocation speed. Evolutionary equations for the dislocation density and the mobile fraction of dislocations are developed to complete the material description. The resulting theory, which allows for the production and interaction of nonuniform dislocation distributions, can model such phenomena as the development of anisotropy with plastic deformation, and material hardening or softening.

36344 **Probabilistic approach to polycrystalline plasticity. II. Applications.** Sackett, S.J. (Univ. of California, Livermore); Kelley, J.M.; Gillis, P.P. *J. Franklin Inst.;* **304**: No. 1, 47-63(Jul 1977).

Using constitutive theory for polycrystalline plasticity, characteristic yield conditions were calculated for several sample materials in which the dependence of the dislocation velocity on stress is given by an empirical power function. The shape of the yield surfaces for these materials varies resembling that of von Mises when the stress exponent is small and that of Tresca when the exponent is large. Additional examples illustrate the ability of the proposed theory to model such phenomena as the development anisotropy during plastic deformation, material hardening and softening, the occurrence of upper and lower yield points, and a Bauschinger effect.

SUPERCONDUCTIVITY

ACOUSTIC, ELECTRIC, MAGNETIC, OPTICAL, AND THERMAL PHENOMENA

REFER ALSO TO CITATION(S) 35548, 35621, 35622, 35701, 35802, 36337

36345 (LBL—6016, pp 89-126) **Physical properties.** 1976.

In Materials and Molecular Research Division annual report, 1976.

Research activities into the physical properties of metals and ceramics at Lawrence Berkeley Laboratory during 1976 are reported. Topics covered include: high field superconductivity; microstructure and mechanical behavior of ceramics, glass-metal, and ceramic-metal systems; high temperature reactions; relation of microstructure to properties in ceramics; and structure and properties of carbon materials and composite materials. (GHT)

36346 **Stress-tensor theory of the ac permeability of defect-free type-II superconductors.** Kerchner, H.R.; Sekula, S.T. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Phys. Rev., B;* **17**: No. 5, 2377-2379(1 Mar 1978).

A stress-tensor formulation of the electrodynamics of type-II superconductors is used to derive the ac permeability of a defect-free cylindrical sample in a large axial dc magnetic field and a small parallel ac field. There is a correction to the theory previously described due to shear stresses in the flux-line lattice; however, this correction is small and does account for the discrepancy between theory and experiment reported earlier.

THEORETICAL PHYSICS

CLASSICAL AND QUANTUM MECHANICS

36347 **New lower bounds for quantum Hamiltonians.** Sachrajda, C.T.; Weldon, H.A.; Blankenbecler, R. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **17**: No. 2, 507-513(15 Jan 1978).

A new variational principle is presented which provides a lower bound to the eigenvalues of a general quantum Hamiltonian. Applications are made to ground and excited states in Schroedinger theory. The variational principle leads naturally to localized (classical-like) states that nevertheless contain effects due to quantum fluctuations in a variational manner. Except for possible exceptional end-point solutions, these "classical" or "semiquantum" configurations provide lower bonds to the true eigenvalue.

36348 (ORNL-tr—4305) **Hypothesis on how "flying saucers" work.** Plantier, J. [nd]. Translated by N. Graves from French, Forces aeriennes Francaises, pp 219-241, Sep 1953. 22p. NTIS, MF A01.

Portions of document are illegible.

Means for propelling flying saucers are discussed. It is suggested that a fluid form of "corpusculo-ondulatory" rays, somewhat similar to cosmic rays, travels through the universe; flying saucers capture and use this energy source for propulsion. The author uses this postulated energy source to explain various appearances of flying saucers. 10 figures. (RWR)

RELATIVITY AND GRAVITATION

36349 Topological invariants and absence of an axial anomaly for a Euclidean Taub-NUT (Newman-Unti-Tamburino) metric. Eguchi, T.; Gilkey, P.B.; Hanson, A.J. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Phys. Rev., D;* **17**: No. 2, 423-427(15 Jan 1978).

Hawking has suggested that a particular Taub-NUT (Newman-Unti-Tamburino) metric might give rise to the gravitational analog of the Yang-Mills pseudoparticle. We extend Hawking's treatment by using the Atiyah-Patodi-Singer index theorem for manifolds with boundaries and conclude that the Taub-NUT metric makes no contribution to the axial anomaly. Thus this metric does not induce chiral-symmetry breakdown as does the Yang-Mills pseudoparticle of Belavin, Polyakov, Schwartz, and Tyupkin.

36350 Multipole moments in general relativity. Place, E.Y.L.T. Chapel Hill, NC; Univ. of North Carolina (1976). 129p. University Microfilms Order No. 77-17,480.

Thesis (Ph. D.).

Multipole moments for "asymptotically Schwarzschild" spacetimes are defined covariantly in terms of the Cauchy data on "asymptotically Schwarzschild" maximal hypersurfaces as surface integrals over the boundary at infinity. In nonempty spacetimes, these surface integrals are equal to volume integrals of the sources, which include the gravitational field itself. Whenever these integrals converge, they are equal to the coefficients of the harmonic functions in an asymptotic expansion of the potentials. The convergence of the integrals is determined by the asymptotic behavior of the Cauchy data, which is in turn determined by the dynamics of the sources in the remote past. The class of static and stationary spacetimes, in which the moment integrals converge to all orders, is discussed in detail. The multipole moments of the Kerr and Tomimatsu-Sato metrics are given as examples. The choice of maximal hypersurfaces in a general space-time is motivated by the conjecture that multipole moments along a foliation of such hypersurfaces give a faithful representation of the distribution of the sources. This is born out in the example of a time-dependent maximal foliation in the Kerr spacetime. Certain general conclusions about the multipole moments of a general spacetime are then presented.

STATISTICAL PHYSICS AND THERMODYNAMICS

36351 Generalized Langevin theory of gas/solid-surface dynamics: A formulation for thermal desorption. Doll, J.D. (University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico 87545). *J. Chem. Phys.;* **68**: No. 7, 3158-3161(1 Apr 1978).

Thermal desorption is examined using a combination of recently developed generalized Langevin methods and techniques related to Bennett's induced trajectory approach. The combined methods appear well suited for the treatment of the dynamics of infrequent, many-body events.

MATHEMATICAL PHYSICS

REFER ALSO TO CITATION(S) 36224, 36322

36352 Graded Lie groups SU(2,2/1) and OSp(1/4). Guersey, F.; Marchildon, L. (Physics Department, Yale University, New Haven, Connecticut 06520). *J. Math. Phys. (N.Y.);* **19**: No. 5, 942-951(May 1978).

We study the graded Lie groups corresponding to the graded Lie algebras SU(2,2/1) and OSp(1/4). General finite group transformations are parametrized, and nonlinear representations are obtained on coset spaces. Jordan and traceless algebras are constructed which admit these groups as automorphism groups.

36353 Sensitivity theory for general nonlinear algebraic equations with constraints. Oblow, E.M. (Oak Ridge National Lab., TN). *Nucl. Sci. Eng.;* **65**: No. 1, 187-191(Jan 1978).

The general development of a sensitivity theory for nonlinear algebraic equations with constraints is presented. Adjoint equations suitable for evaluating derivatives of system response functions with respect to input parameters are derived. The role of the solution of the constrained problem in eliminating nonessential constraints is highlighted. Two sample problems, one linear and one nonlinear, are solved to illustrate the theory.

FUSION ENERGY

PLASMA RESEARCH

PLASMA CONFINEMENT AND HEATING

REFER ALSO TO CITATION(S) 36467

36354 (CONF-760359—7) **Effects of plasma-physical problems on design, operational method, and economics of D-T fusion reactors.** Herold, W. (Kerntechnische Gesellschaft im Deutschen Atomforum e.V., Bonn (Germany, F.R.)). 1976. 3p. Dep. NTIS (US Sales Only), PC A02/MF A01.

From Reactor meeting; Duesseldorf, F.R. Germany (30 Mar 1976).

The most important plasma physics aspects of the confinement concepts (heating process, stability and confinement) and their effects in connection with technical limits are surveyed. The reactor output balances are treated and some key problems are discussed. (MHR)

36355 (EUR-CEA-FC—884(Pt.2)) **Annual progress report of the Grenoble Research Group. January 1 to December 31, 1976.** (Association Euratom-CEA sur la Fusion, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). [nd]. 91p. (In French). Dep. NTIS (US Sales Only), PC A05/MF A01.

Results obtained on: the theory of problems related to the heating of toroidal plasmas, the applications of plasma created through electron cyclotron resonance, and toroidal devices (Petula tokamak and Wega machine) are presented.

36356 (EUR-CEA-FC—890) **Review of the grill theory.** Brambilla, M. (Association Euratom-CEA sur la Fusion, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). Apr 1977. 20p. Dep. NTIS (US Sales Only), PC A02/MF A01.

The theory of launching of r.f. waves in the LHR frequency range using a phased array of waveguides, the grill is reviewed. The scattering matrix description of the grill is first introduced: it allows to consider the grill as a passive element of any conventional microwave circuit. To evaluate the scattering matrix, the complete set of Maxwell's equation is solved exactly in an idealized two-dimensional geometry. The transmission efficiency and the power spectrum launched by the grill are described and interpreted in terms of the surface impedance of the plasma to plane waves. Finally, the approximations implicit in the two-dimensional model are discussed, in particular the effects of coupling to the fast plasma wave.

36357 (EUR-CEA-FC—906) **Radiation from waveguide arrays.** Brambilla, M. (Association Euratom-CEA sur la Fusion, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). Jul 1977. 23p. Dep. NTIS (US Sales Only), PC A03/MF A01.

The theory of phased waveguide arrays (the 'Grill'), developed in view of Lower Hybrid Heating of toroidal plasmas, is applied to two simple cases, in order to gain insight on field distributions and power flow. First, the far-field radiation pattern of the Grill towards an empty half-space is evaluated. Next, the excitation of a passive waveguide by a Grill mounted in a T configuration is considered. These results constitue two examples of exact solutions of Maxwell's equations in relatively complex geometry.

36358 (IAE—2367) **Stability of collisional plasma.** Bogdanov, G.F. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1974. 18p. (In Russian). Dep. NTIS (US Sales Only), PC A03/MF A01.

As was shown experimentally, plasma obtained in rough vacuum is especially stable. Based on the simple plasma particle balance equations it was shown that the presence of sources and sinks of plasma particles leads to the undercutting of the natural oscillation spectrum in the ideal plasma. The stabilisation condition obtained indicates that the plasma stability grows as its density increases. The influence of the gas inflow into plasma is considered and it is indicated that a real plasma is stable against small perturbations.

36359 Plasma enclosed in a magnetic field produced by flexible surface magnets. Schott, L. (Department of Physics, University of Saskatchewan, Saskatoon, Saskatchewan, Canada S7N 0W0). *Rev. Sci. Instrum.;* **49**: No. 4, 491-494(Apr 1978).

A homogeneous steady state plasma with a usable volume of approximately 200 liters and with an electron temperature of 1-2 eV and a plasma density of $\sim 10^9$-10^{10} cm^{-3} is produced in a discharge chamber the outside of whose walls is covered with flexible magnetic strips. This magnet arrangement can be built at a fraction of the cost of a conventional system using rigid surface magnets. The magnetic multipole field leads to an increase of the plasma density by one to two orders of magnitude and it is also found to cause trapping of high energy electrons originating from the discharge region.

36360 Nonadiabaticity in mirror machines. Cohen, R.H.; Rowlands, G.; Foote, J.H. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Fluids;* **21**: No. 4, 627-644(Apr 1978).

An analytic technique for calculating magnetic-moment jumps $\Delta\mu$ of particles in magnetic traps, previously derived for particular two-dimensional vacuum fields, is generalized to nonvacuum fields of arbitrary complexity and applied to high-β mirror machines. The size of a jump depends on the behavior of the magnetic-field strength B(s) near the singularities of B in the complex s plane, where real s measures position along a field line. It is demonstrated that an intrinsic complication of mirror-machine magnetic configurations is the presence of multiple singularities of B, which become closely spaced for field lines near the axis. An expansion in r^2 is used to determine $\Delta\mu$ in the closely spaced regime. The analytic theory is compared with results from a particle-orbit code for several axisymmetric nonvacuum fields, and is found to be in excellent agreement in both the well separated and closely spaced singularity regimes. Finite-β effects are examined using axisymmetric model fields derived from the long, thin equilibrium approximation, with parameters representative of present (2XIIB) and future (MFTF) mirror experiments. It is shown that increasing βappreciably lowers the maximum energy at which particles are confined. The effect is particularly significant if the plasma length is small compared with the vacuum field axial scale length and if the gyroradius is small compared with the plasma radius. The degradation is substantially reduced when the gyroradius at the energy limit is comparable to the plasma radius.

36361 Wave absorption near the electron cyclotron frequency. Fidone, I.; Granata, G.; Ramponi, G.; Meyer, R.L. (Association Euratom-CEA sur la Fusion, Departement de Physique du Plasma et de la Fusion Controlee, Centre d'Etudes Nucleaires,92260 Fontenay-aux-Roses, France). *Phys. Fluids;* **21**: No. 4, 645-652(Apr 1978).

Wave absorption for frequencies near the electron cyclotron frequency for the ordinary and extraordinary modes is investigated. The role of finite electron Larmor radius effects is discussed. A numerical analysis of the relevant dispersion relation in the weakly relativistic and nonrelativistic limit is presented. The density dependence (1/n/sub e/) of the damping of the extraordinary wave for not too small densities and the strong absorption of the ordinary wave for quasi-perpendicular propagation in a hot plasma (T/sub e/> or $\approx$1 keV) are investigated numerically for several angles of incidence.

36362 Experimental study of the axial ion energy distribution in a fast theta pinch. Chiang, T.T.; DeSilva, A.W. (Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742). *Phys. Fluids;* **21**: No. 4, 669-675(Apr 1978).

Ion energy distributions along the axis of the Maryland linear theta pinch were measured by a parallel-plate electrostatic deflection type energy analyzer. Two possible sources of end loss are discussed. The first is acceleration in the axial potential which is a result of the cooling of electrons near the end of the tube. The second is the axial ion temperature that results from relaxation due to different microinstabilities among ion energy components. The particle measurement suggests that the second one is dominant. A two-temperature Maxwellian distribution is observed along the axis. The absence of observable ions from farther than 10-20 cm into the plasma also implies a strong turbulent scattering process is operating.

36363 Experiment on nonadiabatic rf plugging in a cusped field. Hiroe, S.; Sato, T.; Watari, T.; Hidekuma, S.; Kumazawa, R.; Adati, K.; Shoji, T.; Kawasaki, S.; Miyahara, A.; Akaishi, K.; Kubota, Y.; Watanabe, N.; Miyake, S. (Institute of Plasma Physics, Nagoya University, Nagoya 464, Japan). *Phys. Fluids;* **21**: No. 4, 676-681(Apr 1978).

Under nonadiabatic conditions, rf plugging is accompanied by effective ion heating, which in turn causes increased particle losses from a cusp configuration. An empirical scaling relation for rf plugging of line cusp loss is obtained among the required rf electric field, the static magnetic field, and the plasma density, and is compared with the relation obtained by a linear theory.

36364 Anomalous transmission of intense CO_2-laser radiation through an overdense plasma. Rockett, P.D.; Steel, D.G.; Ackenhusen, J.G.; Bach, D.R. (The University of Michigan, Ann Arbor, Michigan 48109). *Phys. Rev. Lett.;* **40**: No. 10, 649-652(6 Mar 1978).

An ultradense ($> 10^{19} e^-/cm^3$), low-temperature ($\sim$ 20 eV), Z-pinch plasma has been used for CO_2-laser-plasma interaction experiments at 10.6μm. Anomalous transmission or radially incident, intense ($\sim 10^{11}$ W/cm^2) laser radiation of 38 nsec full width at half-maximum has been observed to occur through the initially overdense plasma. ν/sub osc//ν/sub th/ is calculated to be $\simeq$ 0.9 at the critical surface, where holographic interferometry shows critical density scale lengths of 70 to 200 μm. The transmitted beam shows increased temporal modulation and a periodic spatial structure resembling Fresnel rings.

36365 Matched plasma heating mode with moving boundaries. Harris, P. (Army Armament Research Development Command, Dover, New Jersey 07801). *J. Appl. Phys.;* **49**: No. 3, 1281-1282(Mar 1978).

The problem of a confined plasma created by laser interaction with a thin metallic layer is investigated for the case of time-dependent confinement boundaries. The self-regulating ablative (SRA) model is applied to obtain the time dependence of plasma pressure, temperature, and density. Krokhin's time-independent boundary solutions are obtained as special cases.

36366 Experimental evidence of ion heating by transit time magnetic pumping. Bardet, R.; Bernard, M.; Briffod, G.; Clement, M.; Gauthier, A.; Gregoire, M.; Grelot, P.; Hesse, M.; Parlange, F.; Pinet, D. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Grenoble, 38 (France). Dept. de Physique du Plasma et de la Fusion Controlee). *Phys. Lett., A;* **63**: No. 2, 97-98(31 Oct 1977).

Transit time magnetic pumping has been used in a tokamak to heat the ions from 200 to 260 eV. Electron density and impurity concentration were not affected during the process. The temperature increase is consistent with theory.

36367 Proposal for skin heating of the Frascati tokamak. Piekaar, H.W.; de Kluiver, H. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). *Phys. Lett., A;* **62**: No. 6, 413-415(19 Sep 1977).

Consideration is given to the turbulent heating by multiple pulses of the Frascati Tokamak plasma. It is concluded that the FT-plasma can be heated to 4 keV with 5 pulses of 26 volt and 50 Hz, provided the energy containment time is 35 ms.

36368 Cyclotron heating in short adiabatic confinement systems. Timofeev, A.V. (I. V. Kurchatov Institute of Atomic Energy, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **3**: No. 4, 516-520(Jul 1977).

In 1963 M. Seidl showed that electrons confined near the minimum of a magnetic field can be captured by cyclotron waves and can undergo an increase in Larmor-revolution energy without sensing the inhomogeneity of the magnetic field of the adiabatic confinement system. This effect may have been manifested in several experiments on cyclotron heating in tokamaks in which a group of high-energy electrons was observed to form near a minimum of the magnetic field, with the result that a hole was burnt through the liners. In the present paper, several factors which can limit the electron heating in real systems are taken into account. It is shown that electrons captured by a wave can turn into "runaways." The conditions for the capture of electrons by cyclotron waves are refined.

36369 Nonlinear conversion of radiation into ion sound near plasma resonance. Galeev, A.A.; Lominadze, D.G.; Machabeli, G.Z. (Abastuman Astrophysical Observatory, Tbilisi). *Sov. J. Plasma Phys. (Engl. Transl.);* **3**: No. 4, 525-527(Jul 1977).

A single nonlinear equation is derived to describe the ion-acoustic instability.

36370 Tokamak apparatus for turbulent heating of plasma. Hosogane, N.; Yamamoto, H. (Osaka Univ., Suita (Japan). Faculty of Engineering); Yamamoto, S.; Asada, M.; Kishimoto, H. *Technol. Rep. Osaka Univ.;* **27**: No. 1337, 59-67(Mar 1977).

A small-scale tokamak apparatus with turbulent heating facilities has been designed and constructed. The plasma loop produced by ohmic heating is successfully sustained in equilibrium. The plasma current in the ohmic heating phase reaches 12 kA at its peak. High voltage reaching about 20 kV per turn can be applied to this plasma loop for turbulent heating. The turbulent heating plasma is found to be macroscopically stable for the plasma current less than 35 kA.

36371 Heating of plasma focus by TEA CO_2 laser. II. Neutron enhancement. Takahashi, R.; Thein, A.; Yamada, Y.; Kitagawa, Y.; Yokoyama, M. (Osaka Univ., Suita (Japan). Faculty of Engineering). *Technol. Rep. Osaka Univ.;* **27**: No. 1337, 193-200(Mar 1977).

In the plasma focus, when the focus pinch was strong, the instability (-- 120 MH_3) was excited in the pinch plasma and this instability threshold was given by p α Vsup(1.5) for D_2 and He gases, while p α V^2 for H_2 gas. It was found that with this instability, X-ray, γ-ray and neutron emissions were increased. When the laser pulse (70 J, 70 nsec) was irradiated to the weak deuterium focus plasma, the total neutron yield was also enhanced to 2.28 times that of without the laser irradiation. The deuterium temperature was also increased from 1.9 keV to 4 keV.

36372 Possibility of medium energy neutral beam injection into stellarator reactor. Miyamoto, K. (Nagoya Univ. (Japan). Inst. of Plasma Physics). *Jpn. J. Appl. Phys.;* **16**: No. 2, 317-319(Feb 1977).

The energy necessary for neutral particles to penetrate into the plasma center may be of the order of 0.6 -- 1 MeV in the case of a fusion reactor. The conversion efficiency to convert such a high energy ion beam into a neutral beam is extremely small. We study

here the case where fast neutral particles are injected so that the ionized fast ions are trapped in helical ripples of the stellarator field. It is shown that the trapped ions can drift into the plasma center even if the energy is of the order of 100 keV.

36373 Plasma heating by ion-cyclotron parametric instability. Shimada, M.; Yatsui, K. (Osaka Univ., Toyonaka (Japan). Faculty of Engineering Science); Yokoyama, M. *Koon Gakkai-Shi;* **3**: No. 1, 36-42(Jan 1977). (In Japanese).

Experimental and theoretical studies are presented of parametric decay instability into two electrostatic ion-cyclotron waves and associated ion heating in a two-ion-species plasma. By modulating an electron beam near the sum of ion-cyclotron frequencies in an electron-beam-plasma system, a radial electric field is produced by a rf excess charge. At high levels of beam modulation above a certain threshold, the beam pumps an ion-cyclotron parametric instability, caused by a relative drift of ions, and correspondingly ion heating takes place rapidly. The instability threshold is determined in a parameter space. The experimental results are compared with a theory that is extended to a small value of k perpendicular rho sub(i) (i.e., long wavelength, forward ion-cyclotron wave). Reasonable agreement is obtained between experiment and theory.

36374 Absorption and reflection of laser radiation by a spreading high-temperature plasma. Afanas'ev, Yu.V.; Demchenko, N.N.; Krokhin, O.N.; Rozanov, V.B. (AN SSSR, Moscow. Fizicheskij Inst.). *Zh. Eksp. Teor. Fiz.;* **72**: No. 1, 170-179(1977). (In Russian).

The plane self-consistent problem of absorption and reflection of an incident monochromatic electromagnetic wave by a spreading high-temperature plasma is considered. Interaction between the radiation and matter is described within the framework of the quasistationary Maxwell equations for the light wave field and the gasodynamic equations which include electron thermal conductivity. A numerical solution of the equations is presented for the neodymium laser radiation ($\omega = 1.8 \times 10^{15}$ s^{-1}) with different pulse duration and power densities ranging from 10^{12} to 10^{16} V/cm^2 and plane uniform targets made of DT or (CH_2)sub(n). The discussion is centering around the efficiency of energy transfer from the laser radiation to the plasma. The calculations performed take into account both bremsstrahlung and a number of collective processes. At power densities of laser radiation more than 10^{13} V/cm^2 processes of abnormal absorption are pointed out to commence to prevail, resulting in significantly lower values of reflected energy.

36375 Rf heating experiments in the Wega Tokamak. Blanc, P.; Hess, W.; Ichtchenko, G. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Grenoble, 38 (France). Service Ionique Generale) (and others). *J. Phys. (Paris), Colloq.;* No. 3, C.165-C.169(1977).

From National congress on plasma physics; Paris, France (6 - 10 Dec 1976).

A power up to 90 kW RF has been applied to the WEGA Tokamak plasma near the lower hybrid frequency (500 MHz), using internal coupling structures. Measurements of electron temperature profiles by different methods are presented. It appears that the electrons do not absorb a significant fraction of HF power. Fast ions are produced during the HF pulse which flux decays in about 100 μs. A bulk ion temperature increase of about 90 eV (or 60%) is observed with a decay time after the HF pulse is turned off of the order of 2 ms.

36376 Experimental study of confinement and stability of a high density plasma in a multiple mirror magnetic field configuration. Tuszewski, M. Berkeley, CA; Univ. of California (1976). 193p. University Microfilms Order No. 77-15,892.

Thesis (Ph. D.).

Multiple mirror magnetic confinement is investigated experimentally with a 10 eV, 10^{13}cm^{-3} hydrogen plasma produced by a Theta Pinch source. Partial plasma stability was achieved with a linked quadrupole field which also enhanced radial losses. A theory was developed for the classical radial losses. Its results, inserted in a numerical simulation of the experiment, agreed quantitatively with the observed losses. A Theta Pinch plasma source was designed to allow transient experiments on the seven cells, two meter long multiple mirror at Berkeley, in a density range 10^{13} to 10^{14}cm^{-3}. The gun output at the end of the guide field between the Theta Pinch coil and the multiple mirror region was a sharp plasma pulse of intensity approximately 10^{14}cm^{-3} with a ratio of drift to thermal velocity close to unity (approximately 10 eV).

PLASMA DIAGNOSTICS

36377 Multiple species ion energy analyzer applied to laser-induced plasma experiments. Hahn, S.F.; van Hulsteyn, D.B.; Becker, M.F. (Department of Electrical Engineering, The University of Texas at Austin, Austin, Texas 78712). *Rev. Sci. Instrum.;* **49**: No. 4, 473-476(Apr 1978).

We have developed a device which employs parallel dc electric and magnetic fields in combination with an array of collectors and accompanying electronic circuits to measure simultaneously the momentum distributions of different ion species from a laser produced plasma. This diagnostic system automatically separates the ion species according to mass to charge ratio and utilizes the cyclotron motion to provide the momentum separation. The principle of operation, design configuration, and circuitry for the system are presented along with representative data obtained from a series of laser-induced plasma experiments.

36378 Air transport coefficients from electric arc measurements. Devoto, R.S.; Bauder, U.H.; Cailleteau, J.; Shires, E. (University of California, Lawrence Livermore Laboratory, Livermore, California 94550). *Phys. Fluids;* **21**: No. 4, 552-558(Apr 1978).

A wall-stabilized arc has been operated at various currents in air at 1 atm pressure. Measurements have been made of the axial electrical field strength, the emitted radiation, and the radial temperature profiles. These data were used to deduce the electrical conductivity, the emission coefficient for optically thin radiation, and the thermal conductivity as a function of temperature. The deduced values are found to be in accord with theoretical computations.

36379 Multi-electrode plasma probe for orbit-limited-current measurements. II. Numerical verification. Parker, L.W.; Laframboise, J.G. (Lee W. Parker, Inc., Concord, Massachusetts 01742). *Phys. Fluids;* **21**: No. 4, 588-591(Apr 1978).

A flat-ended variant of a multi-electrode electrostatic plasma probe design, previously proposed by Laframboise and Parker, is described. The probe consists of a collector, a guard, and a sleeve electrode. Besides being easier to construct, this modified probe geometry is more amenable to numerical verification of its operating properties. Such a verification is carried out by numerically following selected collisionless orbits of charged particles in the electric field of the probe. By the same means, an orbit-limited operating regime of electrode bias combinations is also found. It is found that if the sleeve is given an attractive bias at least three times as large as that of the collector and guard, relative to space potential, then one achieves the intended probe operation, which simulates that of an orbit-limited spherical Langmuir probe in collisionless conditions but with certain restrictions on probe operation removed or relaxed. It is concluded that experimental tests of the proposed probe configuration are desirable.

36380 Convection in vertical high-pressure mercury arcs. Zollweg, R.J. (Westinghouse RD Center, Pittsburgh, Pennsylvania 15235). *J. Appl. Phys.;* **49**: No. 3, 1077-1091(Mar 1978).

Convection in wall-stabilized high-pressure arcs is found to be highly sensitive to the relative material properties of the discharge gases. A method has been found to experimentally determine net-radiative-emission coefficients that are consistent with more reliably calculated electrical and thermal conductivities. The electrical conductivity of mercury arcs obtained using the electron scattering cross section for mercury derived by Rockwood gives better agreement with experimental temperature profiles than does that obtained by use of McCutchen's cross section. Using these material properties with a theoretical convection model, good agreement was obtained with measured arc-temperature profiles in the midplane, with the conical appearance at the bottom of the vertical arc and with the electrical properties. For 18-mm-i.d. walls and mercury pressures up to 13 atm, the reduction in radiation found for high mercury pressures was found to be caused by self-absorption and not by an increase in radial thermal conduction because of turbulence or shear-induced eddies. No evidence was found for such eddy diffusion, turbulence, or for multicellular convection.

36381 X-ray line emission and plasma conditions in exploded Fe wires. Burkhalter, P.G.; Dozier, C.M.; Stallings, C.; Cowan, R.D. (Naval Research Laboratory, Washington, D.C. 20375). *J. Appl. Phys.;* **49**: No. 3, 1092-1098(Mar 1978).

Single-wire Fe spectra collected from two different exploded-wire generators (Gamble II and Owl II) were analyzed to determined the ionization stages produced in the plasmas. The temperature for the hot-plasma pinches for both generators was 1.4 +- 0.2 keV at which an abundance of Fe XXIV transitions is produced. The Fe K spectra from exploded wires are basically similar to those produced in the pinched plasma generated randomly in the vacuum spark; however, the exploded wires have lower plasma temperatures than the hottest pinches produced in the vacuum spark. A detailed interpretation of the Fe L spectra formed in the exploded wires permitted line and ionization stage identifications in the 7-12-A region. Such spectroscopic data is useful for analysis of complex Fe spectra generated in multitemperature plasma devices like Tokamaks.

36382 Implosion experiments with D_2, ^{3}He filled microspheres. Slivinsky, V.W.; Ahlstrom, H.G.; Nuckolls, J.H.; Larsen, J.; Weinstein, B.W.; Tirsell, K.G.; Storm, E.K.; Leipelt, G.R. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *J. Appl. Phys.;* **49**: No. 3, 1106-1109(Mar 1978).

Glass microspheres filled with D_2 and ^3He were imploded using the LLL 1.06 μm Argus laser. The energetic 14.7-MeV protons from the D-^{3}He reactions were measured. By taking the ratio of the number of D-^{3}He reactions to the D-D reactions, ion temperatures were calculated. The results were compared with numerical modeling of the experiments.

36383 New developments in laser diagnostics for tokamak plasmas. Chen, F.F. (Univ. of California, Los Angeles). *IEEE Trans. Plasma Sci.;* **PS-5**: No. 4, 231-241(Dec 1977).

New types of infrared and far-infrared lasers can be used to make otherwise impossible measurements of plasma parameters in the next generation of large tokamaks. Recent progress in the development of such new diagnostic techniques is reviewed.

36384 Spectrally resolved measurements of collective scattering from thermal plasma fluctuations using a CW-CO_2 laser. Hailer, H. (Stuttgart Univ. (TH) (Germany, F.R.). Inst. fuer Plasmaforschung). *Phys. Lett., A;* **62**: No. 6, 419-421(19 Sep 1977).

CO_2 laser scattering is applied to a magnetically stabilized hydrogen arc. The ion feature is resolved by means of a Fabry-Perot interferometer. The radiation power in the resolved spectral interval is typically 10^{-12} W. The technique of measurement is described and results are given.

36385 Measurement of the electron temperature profiles by Thomson scattering using a single laser shot: application to TFR Tokamak. Lasalle, J.; Platz, P. (Association Euratom-CEA sur la Fusion, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). *Rev. Phys. Appl.;* **12**: No. 8, 1181-1185(Aug 1977). (In French).

From National congress on plasma physics; Paris, France (6 Dec 1976).

The most straightforward and widely used way, up to now, to measure an electron temperature profile Tsub(e) (r) in a tokamak was a shot by shot method using a multichannel spectrometer giving a single point of the Tsub(e)(r) profile per shot. A two-channel, compact and inexpensive spectrometer was developed. The simplicity of its design and operation allows the simultaneous use of many instruments for the measurement of the full Tsub(e) (r) profile with a single laser and tokamak shot.

36386 Interference study of the corona of a laser-produced plasma during the heating pulse. Zakharenkov, Y.A.; Krokhin, O.N.; Pustovalov, V.V.; Silin, V.P.; Skilzkov, G.V.; Starodub, A.N.; Tikhonchuk, V.T.; Shikanov, A.S. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **3**: No. 4, 414-419(Jul 1977).

An interference technique reveals the formation of an "opaque" zone in the corona of a laser-produced plasma. A detailed analysis shows that this zone results from stimulated Brillouin scattering in the corona.

36387 Determination of the impurity concentration in a hot plasma from the width of the laser-fluorescence line. Abramov, V.A.; Lisitsa, V.S. (I. V. Kurchatov Institute of Atomic Energy, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **3**: No. 4, 451-454(Jul 1977).

A method is described for determining the impurity concentration from the width of the laser-fluorescence line in a hot plasma. In the method, the inhomogeneous Doppler broadening is eliminated through a saturation of this transition by the laser beam. It is thus possible to distinguish the residual homogeneous broadening, due to collisions of the atom with heavy plasma particles: protons and impurity ions. This method is not based on any model for the level populations, and it yields the effective charge Z/sub eff/ directly.

36388 Local counting efficiency of a Ceratron multiplier for plasma diagnoses on charge-exchanged fast atoms. Takeuchi, H.; Takahashi, K.; Funahashi, A.; Yoshida, H. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). *Jpn. J. Appl. Phys.;* **16**: No. 5, 873-874(May 1977).

Published in summary form only.

36389 Intrinsic germanium Ge(I) detector for measurements of soft x-ray spectra radiated from high temperature tokamak plasmas. Kumagai, K.; Matoba, T.; Funahashi, A.; Kawakami, T. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). *Jpn. J. Appl. Phys.;* **16**: No. 5, 871-872(May 1977).

36390 Optical measurement of laser-driven imploding shock wave. Azechi, H.; Sakagami, Y. (Gifu Univ. (Japan)); Yamanaka, T.; Yamanaka, C. *J. Phys. Soc. Jpn.;* **42**: No. 4, 1362-1365(Apr 1977).

In this laser-plasma experiments, technique of simultaneous optical measurement using Jamin interferometer, Schlieren method and shadowgraph was developed. The spatial and temporal resolutions of these methods were 5 μm and 30 psec, respectively. The existence of a shock wave propagating into the target was confirmed. The energies of shock waves in the target and in air were estimated by using the blast wave theory.

36391 Semi-analytical expression of absorption curve of x-ray intensity for determination of electron temperature in plasma. Matsukawa, Y. (Osaka City Univ. (Japan). Research Inst. for Atomic Energy). *Jpn. J. Appl. Phys.;* **16**: No. 2, 311-316(Feb 1977).

Using parameter of an absorber other than the real thickness, the absorption curve of the intensity of bremsstrahlung or recombination continuous X-rays from a plasma for determining the electron temperature is expressed in a simple analytical relation approximately. This relation can be used to determine the temperature and the proportion of each component, when the energy distribution of electrons in the plasma consists of more than two components in the form of a Maxwellian distribution. Some results of the calculation of the absorption curve are shown.

36392 Spectral line broadening by nonuniform plasmas. I. Doppler profile and ion temperature determination. Sato, M. (Yamagata Univ., Yonezawa (Japan). Faculty of Engineering). *Yamanashi Daigaku Kyoikugakubu Kenkyu Hokoku;* **14**: No. 2, 67-73(Feb 1977). (In Japanese).

The spectrometry of plasma is the powerful means of diagnosing the plasma. In this paper, the spread of spectral lines due to the Doppler effect of the particles making thermal movement is considered as a luminescence process, and the total intensity distribution of spectral lines in spatially heterogeneous plasma is determined. The spatial distribution of ion temperature can be obtained easily from this distribution by partial reverse transformation. The Doppler width of heterogenous plasma is calculated and compared with the case of uniform plasma. The reverse transformation is carried out according to the method by Nestor and Olson. The original function of ion temperature is restored from the total intensity distribution by the method proposed in this paper, but the restoration of density is not carried out because it is impractical in view of the errors in measurement and reverse transformation. The error in the calculation of ion temperature due to the selection of wave length widths is estimated, and finally, the error due to discontinue a part of the calculation of reverse transformation is studied. It is possible to determine ion temperature correctly by linear extrapolation even if the calculation is discontinued at a proper point.

36393 Study of plasma focus. Hirano, K.; Majima, K. (Gunma Univ., Maebashi (Japan)). *Denki Gakkai Ronbunshi, A;* **96**: No. 11, 543-550(Nov 1976). (In Japanese).

The behavior of the plasma acceleration between electrodes, the phenomena due to the pinch effect at the top of the electrodes and the neutron emission mechanism were experimentally studied. The plasma focus device was a Mather type coaxial discharge device, and the instruments used for the present purpose were a Rogoski coil, an image converter camera, a scintillation detector and a silver foil activation counter. The results of the present experiment were as follows. Plasma focus was not definitely made under the same condition. When the focus was seen, a dip was observed in the discharge wave form, and the emissions of X-ray and neutrons were detected. The angular anisotropy of neutron emission was observed, and corresponds to a beam target model. The phenomena showing the occurrence of focus were seen, when the current sheet was produced at a delayed time after discharge, and arrived at the muzzle with large velocity. The relation between the number of emitted neutrons and the velocity of the current sheet was obtained, whereas no systematic relation exists between the number of emitted neutrons and the velocity of pinch. When the focus was not observed, no dip was seen in current wave form, and the emissions of X-ray and neutrons were not detected. The reason of no focus was considered.

36394 Electron-optic methods with the use of plastic scintillators for studies in the x-ray region. Bryukhnevich, G.I.; Kas'yanov, Yu.S.; Stepanov, B.M.; Chevokin, V.K.; Shchelev, M.Ya. (AN SSSR, Moscow. Fizicheskij Inst.). *Prib. Tekh. Eksp.;* **18**: No. 6, 228-231(Nov 1975). (In Russian).

For English translation see the journal Instrum. Exp. Tech.

The procedure and results of using image converters (i.c.) with plastic scintillators at the input are analyzed. Cameras designed using such i.c. are distinguished by high space and time resolution. In investigating x radiation from a laser plasma, the maximum achieved time resolution amounted to approximately 0.5 nsec.

PLASMA KINETICS - GENERAL

36395 (LA—7082-PR) **LASL Controlled Thermonuclear Research Program. Progress report, January—December 1976.** Thomas, K.S. (comp.). (Los Alamos Scientific Lab., N.Mex. (USA)). Mar 1978. Contract W-7405-ENG-36. 235p. Dep. NTIS, PC A11/MF A01.

This annual progress report is divided into the following sections: (1) Scyllac feedback sector experiments, (2) staged theta-pinch program, (3) toroidal reverse-field pinch, (4) Scylla IV-P

linear theta-pinch experiments, (5) gun injection experiment, (6) Scylla I-C, laser-plasma interaction studies, (7) field reversal theta pinch, (8) Implosion Heating Experiment, (9) experimental plasma physics, (10) plasma diagnostics, (11) high-beta tokamak, (12) theory, (13) computers, (14) engineering, (15) magnetic energy transfer and storage, (16) magnetic confinement systems studies, and (17) intense neutron source facility. (MOW)

36396 Intense ion beam extraction through a non-equilibrium plasma sheath. Jones, R. (General Atomic Co., San Diego, Calif. (USA)). *Phys. Lett., A;* **62**: No. 7, 493-494(3 Oct 1977).

The usual limitations on extracted ion current and energy partition with electrons can be relaxed for an ion source operated with a non-stationary sheath.

36397 Collisional complexes in a plasma and their effect on the electrical conductivity. Vorob'ev, V.S.; Khomkin, A.L. (Institute of High Temperatures, Academy of Sciences of the USSR). *Sov. J. Plasma Phys. (Engl. Transl.);* **3**: No. 4, 499-504(Jul 1977).

The state density of electron— (nearest-ion) pairs is analyzed. The lifetime is estimated for unstable states with a positive energy, i.e., for collisional complexes. These states reduce the electrical conductivity. Their effect on the electrical conductivity is estimated, and the results are compared with experimental data in argon and cesium plasmas.

36398 PASCAL: a multidisciplinary data base. Its use in atomic and molecular physics and plasma and fluid physics. Buhr, J.M.; Degen, C. (Centre National de la Recherche Scientifique, 75 - Paris (France)). *J. Phys. (Paris), Colloq.;* No. 3, C.249-C.251(1977). (In French).

From National congress on plasma physics; Paris, France (6 - 10 Dec 1976).

Description is given of the system PASCAL of the 'Centre de Documentation' of C.N.R.S., which deals with a multidisciplinary data base. PASCAL is an automated system for input, treatment and selective dissemination on a wide scope of scientific and technical fields. Its products are tape series, 'Bulletins Signaletiques', documentary profiles, retrospective searching as well in batch as on line. As illustration, an example is given in atomic and molecular Physics.

36399 'GAPHYOR': A computerized retrieval system for the properties of atoms, molecules, gases and plasmas. Delcroix, J.L. (Paris-11 Univ., 91 - Orsay (France). Lab. de Physique des Plasmas). *J. Phys. (Paris), Colloq.;* No. 3, C.141-C.154(1977). (In French).

From National congress on plasma physics; Paris, France (6 - 10 Dec 1976).

GAPHYOR (Gas Physics Orsay) is a computerized retrieval system for simple properties of atoms and molecules (e.g. energy levels, radiative life-times, dipole moments, polarisabilities...), their interaction properties (e.g. cross sections, reaction rates...) and the macroscopic properties of gases and plasmas (e.g. viscosities, electron and ion mobilities, thermodynamic functions ...). Chemical system covered, must be made from a small number of elements (1 to 4 in the most recent version) and include molecules of not more than eight atoms. This paper describes the basic principles of GAPHYOR and describes through some simple statistics, the present state of the system after six years of operation. At the beginning of November 1976 the file contains more than 33000 lines and it grows by about 10000 lines every year. This information comes from more than 300 journals, but 42% of the results is taken from the four main journals. The geographics analyses of the file provides interesting conclusions concerning the scientific production of the research centers and the policy of the countries with respect to scientific edition. Finally, the qualities, short comings and possible improvements of GAPHYOR are discussed.

36400 Energy loss and appearance of the distribution function of an electron beam interacted with plasma in dependence on the beam axis distance. Levitskii, S.M.; Nuriev, K.Z. (Azerbajdzhanskij Gosudarstvennyj Univ., Baku (USSR)). *Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Tekh. Mat. Nauk;* No. 1, 116-120(1975). (In Russian).

A beam interacting with plasma under different damping pressures was studied. As a result, the beam diameter increased. The apparent increase occurs because of "wings" on the radial distribution curve. In addition, the diameter decreases with growing damping potential. Since enlargement of the beam is mainly due to slow electrons, it is more reasonable to consider that the most intensive interaction is undergone by the electrons on the beam axis, with the lowest, for some rason, being thrown to the periphery, for example, by a gradient force that expels particles from the field where the tension of the high-frequency field is especially high. This force acts on the fast and slow electrons, which have a lower axial velocity and under its action are able to further convert to a radial direction. The experiment showed that the effect may be observed when a small radial field arises from incomplete compensation of the space charge on the beam.

PLASMA KINETICS - EXPERIMENTAL

36401 Spectral diagnosis of plasma of high current pulse discharges in deuterium. Aleksandrovich, K.V.; Berezin, I.A. *Zh. Prikl. Spektrosk.;* **28**: No. 2, 209-213(Feb 1978). (In Russian).

High current pulse discharges were investigated in metal chambers filled with dueterium (I/sub max/ = 300 kA, U = 7 kV), using the methods of photographic spectroscopy with time resolution. The brightness temperature of the plasma was measured by the intensity of the long-wave maximum of the self-reversal line D/sub α/. The maximum temperature along the light beam was determined by the Bartels method. A method for measuring the density of electrons along the half-width of the line D/sub α/ is proposed and applied. It is based on finding the true profile of this line from the self-reversal contour. The concentration of the impurities entering the discharge plasma from the chamber walls was measured by a spectral method. Changes during the discharge in the main parameters of the plasma: temperature, electron density, composition and gas-kinetic pressure are studied, and also the dependence of these parameters on the initial deuterium pressure. Energy losses are estimated and the negative role of impurity ions in the deuterium plasma is noted.

36402 Observation of intercombination lines $1s3p\ ^3P_1 \rightarrow 1s^2\ ^1S_0$ of multicharged He-like ions in laser-produced plasmas. Boiko, V.A.; Faenov, A.Y.; Pikuz, S.A.; Skobelev, I.Y.; Vinogradov, A.V.; Yukov, E.A. (AN SSSR, Moscow. Fizicheskij Inst.). *J. Plasma Phys.;* **10**: No. 17, 3387-3394(1 Dec 1977).

The intercombination lines $1s3p\ ^3P_1 \rightarrow 1s^2\ ^1S_0$ of the ions Mg XI, Al XII, P XIV, SXV and Cl XVI have been observed for the first time in the spectra of laser-produced plasmas. The wavelengths and relative intensities of such lines were measured. The identification of the observed lines was carried out by means of a comparison of the experimental wavelengths and intensities with the theoretical ones. The dependence of the relative intensities of such lines on the plasma parameters was investigated.

36403 First measurements of electron-cyclotron emission spectra from PLT. Rutgers, W.R.; Boyd, D.A. (Maryland Univ., College Park (USA)). *Phys. Lett., A;* **62**: No. 7, 498-500(3 Oct 1977).

The frequency spectrum of electron-cyclotron radiation from the PLT-device has been measured by observing in a vertical direction. The line profiles of 2ω/sub ce/ and 3ω/sub ce/ are broad and show a central intensity dip. An interpretation is given in terms of reflections on the vacuum vessel and self-absorption.

36404 Upper pressure limit for the efficient operation of a plasma focus device. Gratton, R.; Kelly, H.; Milanese, M.; Pouzo, J. (Buenos Aires Univ. Nacional (Argentina). Facultad de Ciencias Exactas y Naturales). *Phys. Lett., A;* **62**: No. 6, 422-424(19 Sep 1977).

The observation that the neutron yield (as a function of pressure) in a plasma focus device drops for high pressures, when the energy available becomes insufficient to fully ionize the gas swept during the coaxial propagation is reported.

36405 Electron loss of fast H^- ions and H^0 atoms in a plasma target. Dimov, G.I.; Ivanov, A.A.; Roslyakov, G.V. (Institute of Nuclear Physics, Siberian Branch, Academy of Sciences of the USSR, Novosibirsk). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 9, 1091-1095(Sep 1977).

The electron loss of negative ions and hydrogen and deuterium atoms with energies 0.4—0.9 MeV is studied experimentally for lithium and magnesium plasma targets. Measurements of the relative cross sections for electron loss are reported. The maximum yield of neutral atoms from the negative ions H^- and D^- in stripping in plasma targets is found to be 80—82% over the ion energy range studied here.

36406 Supercompression of intense ion beams in a collapsing pinch. Winterberg, F. (Nevada Univ., Reno (USA). Desert Research Inst.). *Z. Naturforsch., a;* **32**: No. 8, 840-843(Aug 1977).

Intense ion beams produced in magnetically insulated diodes become fast plasma jets in the drift tube. If a pich discharge is made over these fast jets they can be magnetically compressed to very small diameters of less than 10^{-2} cm. Such fast highly focused plasma beams may have important applications for the ignition of thermonuclear microexplosions.

36407 Focusing of high-energy plasma streams in the axisymmetric magnetic field of a short coil. Kalmykov, A.A.; Tereshin, V.I.; Chebotarev, V.V.; Yakubovskii, V.G.; Tkachenko, V.I. (Physicotechnical Institute, Academy of Sciences of the Ukrainian SSR, Khar'kov). *Sov. J. Plasma Phys. (Engl. Transl.);* **3**: No. 4, 429-434(Jul 1977).

The motion of high-energy plasma streams in the axisymmetric magnetic field of a short coil is studied. The experiments show that if the external magnetic field is completely shielded from the plasma volume the stream is focused at the axis of the system in a volume essentially free of external fields. The axial position of this

focal region can be changed by changing the magnetic field of the coil.

36408 Decay of the return current induced by a relativistic electron beam in a plasma. Shkvarushets, A.G.; Krementsov, V.I.; Strelkov, P.S. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **3**: No. 4, 435-437(Jul 1977).

It is found experimentally that in a comparatively dense plasma (n/sub p/$>10^{12}$ cm^{-3}) the return current induced by a relativistic electron beam in a plasma decays because of a lack of electron emission from the collector. At densities n/sub p/$<10^{12}$ cm^{-3} the decay of the return current is independent of the emissivity of the collector, apparently due to a strong beam—plasma interaction. A plasma collector which is a prolific emitter can be produced by means of an external source (the spark source operates 1 μsec before the relativistic electron beam is injected), or it can be produced by the relativistic electron beam itself, through an interaction of this beam with the collector material. In the first case the return current does not decay if n/sub p/$>10^{12}$ cm^{-3}; in the second case, there is a partial disruption of the return current. The degree of residual current neutralization increases with increasing beam current.

36409 Energy measurements in a current-carrying plasma in a stellarator. Andryukhina, E.D.; Fedyanin, O.I. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **3**: No. 4, 447-450(Jul 1977).

An analytic expression is derived for the change in the longitudinal magnetic flux in a current-carrying plasma in a stellarator. The pressure balance is governed primarily by the stellarator field. Measurements of the plasma energy and of the energy confinement time are reported.

36410 Spectroscopic study of the plasma properties in a steady plasma centrifuge with a low degree of ionization. Zhuzhanashvili, A.I.; Ivanov, A.A.; Cherkasova, E.K.; Shapkin, V.V. (I. V. Kurchatov Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **3**: No. 4, 479-481(Jul 1977).

A spectroscopic study has been made of the properties of the weakly ionized plasma rotating in a steady plasma centrifuge in crossed electric and magnetic fields. The rotation velocities of neutral helium and argon are found to be 1.6×10^6 and 5×10^5 cm/sec, respectively. The measured temperature of the neutral argon is 4.5 eV; the electron temperature is 35 eV. The results are interpreted.

36411 Steady discharge in crossed electric and magnetic fields. Babaritskii, A.I.; Ivanov, A.A.; Severnyi, V.V.; Shapkin, V.V. (I. V. Kurchatov Institute of Atomic Energy, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **3**: No. 4, 505-508(Jul 1977).

Electrical and mass-spectrometric measurements are reported for the weakly ionized noble-gas plasma produced in a steady discharge between two coaxial electrodes immersed in a longitudinal magnetic field. Even in a simple steady system of this type with crossed electric and magnetic fields it is possible to achieve a spatial separation of elements according to mass, but the degree of separation is severely limited by structural disadvantages of this system. The separation mechanism is discussed, and concrete waves for improving the degree of separation are pointed out. Systems of this type can be used as efficient plasma-chemical reactors, in which the "quenching" problem is resolved through the spatial separation of the reaction products.

36412 Control of plasma potential with an electron emissive grid in a Q-machine. Hioki, Y. (Daido Inst. of Tech., Nagoya (Japan)); Okuda, T. *Jpn. J. Appl. Phys.;* **16**: No. 4, 609-615(Apr 1977).

Control of plasma potential is studied with a BaO-coated grid which is heated by the thermal radiation of a hot plate in a single-ended Q-machine using potassium. The plasma potential V sub(s) is varied by electrons emitted from the grid. When an a.c voltage v sub(ex) (6-80 kHz) is superposed on the bias voltage V sub(g) of the grid, the grid excites two modes of oscillations. The first mode is an ion wave or a free streaming with a phase velocity of about 2.2×10^5 cm/s. The second mode is a potential oscillation ϕ_2 whose amplitude is almost constant over the plasma column, and the phase velocity is very high (higher than the thermal velocity of electrons 3.7×10^7 cm/s). The efficiency for exciting the second mode ϕ_2/v sub(ex) is large (0.4 at V sub(g) = -2 V) and depends heavily on the bias voltage V sub(g).

36413 Line broadening measurement in high density plasma, 1. H sub(α) and H sub(β). Okasaka, R.; Nagashima, M.; Fukuda, K. (Kyoto Univ. (Japan). Faculty of Engineering). *J. Phys. Soc. Jpn.;* **42**: No. 4, 1339-1347(Apr 1977).

The profiles of H sub(α) and H sub(β) were measured in a shock heated plasma of high electron density of 1 to 3×10^{17} cm^{-3}. The measured profiles are compared with the theoretical ones, and some discrepancies are pointed out; the measured half width is larger than the theoretical one for H sub(α), and the measured depth of the central dip of H sub(β) is smaller than the depth calculated by theories. The dependence of the measured depth of the dip on electron density agrees with the extrapolation from the experimental result by Wiese et al. in electron density less than 10^{17} cm^{-3}, which indicates the effect of the ion motion. The measured value of the degree of asymmetry of H sub(β) profile, i.e., the ratio of the difference between the blue and the red peak intensity to the blue one, is approximately predicted by the theory including the effect of the quadrupole interaction between a radiating atom and the nearest ion.

36414 Study of plasma focusing. Hirano, K.; Majima, K. (Gunma Univ, Kiryu, Jpn). *Electr. Eng. Jpn. (Engl. Transl.);* **96**: No. 6, 16-22(Nov-Dec 1976).

As reported elsewhere, cases of plasma focusing and defocusing occur under the same experimental conditions. In focusing, the current dip appears and irradiation of neutrons and X-rays takes place. The neutron yield exhibits angular anisotropy, supporting a beam target model in which a beam is directed at angle of 10° with respect to the axis. In focusing, the current sheet velocity V/sub s/ and its pinch velocity V/sub p/ at the electrode end are larger than in case of defocusing. However, the arrival time of the current sheet at the gun openning is longer. Specifically, plasma focusing takes place when the current sheet formation is delayed and the current sheet arrives at the gun opening at high velocity. The neutron yield N is proportional to 11th power of V/sub s/, but N is independent of V/sub p/. In defocusing, no current dip appears and neither neutron nor X-ray irradiations takes place. Plasma defocusing occurs for this reason: inductance variation caused by plasma pinch at the electrode end results in the generation of abnormal voltage which propagates toward the gun bottom in a space between electrodes and produces redischarges between electrodes. These actions reduce the current at the pinching portion of the plasma and suppress pinching. Accordingly, no current dip is observed; neither X-ray nor neutron irradiations take place. 16 refs.

36415 Preliminary investigations of a non-cylindrical Z-pinch supplied from a 25 kJ current generator. Nowikowski, J. (Institute of Nuclear Research, Warsaw (Poland)). *Nukleonika;* **19**: No. 12, 1081-1090(1974).

The paper presents a brief description of a NZP-25 experimental device designed for non-cylindrical Z-pinch investigations in the Mather-type electrodes system, as well as the results of measurements of some of the basic physical values connected with the above phenomena as achieved in the course of the preliminary investigations. Discharge currents, at a deuterium pressure of 1 Torr and a condenser bank charging voltage of 36 kV, achived a maximum of 290-300 kA with a rise-time of 2.5-2,6 μsec. The occurence of a hot plasma cumulation zone (a non-cylindrical Z-pinch) in the vicinity of the center electrode's face, was established in which the average electron energy was estimated to be 1.5-3 keV. The neutron yield was measured as a function of the deuterium pressure within the range of 0.5-2 Torr, and as a function of the condenser bank charging voltage within the range of 30-36 kV. The maximum neutron yield at the 1 Torr deuterium pressure and at a charging voltage of 36 kV achieved a value of 2.10^9.

PLASMA KINETICS - THEORETICAL

36416 (IPP—6/155) **Diffusive tokamak equilibria, generalized bootstrap currents and the relation between particle diffusion and magnetic field diffusion.** Borrass, K.; Pfirsch, D. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). Mar 1977. 21p. Dep. NTIS (US Sales Only), PC A03/MF A01.

A condition for general axisymmetric diffusive equilibria which relates the outward diffusion flux with the toroidal current density is derived. In an approximate version it requires that some effective diffusion velocity Vsub(D)* must not exceed the poloidal magnetic diffusion velocity Vsub(m). Relevant consequences follow in the regime of anomalous diffusion if diffusion is caused by an anomalous parallel electron viscosity instead of an anomalous perpendicular resistivity. In the former case Vsub(D)* equals the real diffusion velocity Vsub(D) and an anomalous bootstrap current arises which leads to rather low upper limits for βsub(p). If the usual trapped ion or Bohm diffusion is assumed to be caused by an enhanced viscosity, no stationary equilibria would be possible in a system governed by the respective diffusion law.

36417 Effect of turbulence on the rate of energy loss by a test charge moving in a plasma. Swami, K.C.; Sharma, S.R. (Rajasthan Univ., Jaipur (India). Dept. of Physics). *Phys. Lett., A;* **63**: No. 2, 112-114(31 Oct 1977).

The energy loss rate of a charge moving in a turbulent plasma is calculated using the dielectric formalism. It is found that net effect of the turbulence is to decrease the energy loss rate of the test charge.

36418 Virial theorem for relativistic plasmas. Georgiou, A. (Westfield Coll., London (UK)). *Phys. Lett., A;* **62**: No. 7, 484-486(3 Oct 1977).

A tensor form of the virial theorem is obtained for a relativistic charged thermodynamic perfect fluid. As a particular application, the equilibrium of a spherically symmetric charged dust cloud is considered.

36419 'Parodie', a large homogeneous stationary plasma. Truc, A.; Mantei, T.D.; Gresillon, D. (Ecole Polytechnique, 75 - Paris (France). Lab. de Physique des Milieux Ionises). *Rev. Phys. Appl.;* **12**: No. 8, 1143-1148(Aug 1977). (In French).

From National congress on plasma physics; Paris, France (6 - 10 Dec 1976).

A low pressure discharge plasma with magnetic multipolar confinement has been constructed to experimentally investigate turbulence phenomena. Its main characteristics are described: the technology (cylindrical machine 1 m in diameter and 1 m long, sliding vacuum rule section, permanent magnets...); and the plasma parameters (10^{9}-10^{10} cm^{-3} electron density; homogeneous within 1% in a volume of 0.3 m^{3}, fluctuations at thermal level).

36420 Numerical simulation of laser compression and heating of simple shell targets. Anisimov, S.I.; Ivanov, M.F.; Inogamov, N.A.; Pashinin, P.P.; Prokhorov, A.M. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR). *Sov. J. Plasma Phys. (Engl. Transl.);* **3**: No. 4, 409-414(Jul 1977).

A model is proposed for the heating and compression of spherical shells of hydrogen by laser pulses with energies of several hundred joules. The results of numerical calculations are reported. A study is made of how the neutron yield and the limiting compression are affected by a preheating of the central part of the target by fast electrons, by limitations on the heat flux, by variations in the equation of state, and by the rate of energy exchange between the plasma components. The energetic characteristics of the process are strongly affected by the details of the model concerning the preheating and a restriction on the thermal conductivity.

36421 Hydrodynamics of a parametrically absorbing laser-produced plasma undergoing spherical expansion. Polyanichev, A.N.; Tikhonchuk, V.T.; Fetisov, V.S. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **3**: No. 4, 420-424(Jul 1977).

The anomalous absorption of laser radiation in a spherically symmetric solid deuterium target is simulated numerically. The role played by parametric effects in the plasma hydrodynamics is determined. The calculated results agree qualitatively with experiment.

36422 Cutoff of a beam—plasma discharge by a transverse electric field. Ivanov, A.A.; Leiman, V.G. (Moscow Physicotechnical Institute, Dolgoprudnyi). *Sov. J. Plasma Phys. (Engl. Transl.);* **3**: No. 4, 444-446(Jul 1977).

The effect os neutral beam injection on the current flow in a rotating plasma are calculated.

36423 Ion velocity distribution and drift velocity near a wall in a constant electric field. Shcherbinin, P.P.; Chervyakov, I.B. (Physicoenergetics Institute, Obninsk). *Sov. J. Plasma Phys. (Engl. Transl.);* **3**: No. 4, 474-478(Jul 1977).

A plasma under laboratory conditions is generally bounded by walls. A wall makes the ion velocity distribution non-Maxwellian, since the wall either does not emit ions or emits them with properties different from those of the plasma ions. An electric field, usually directed toward the wall, has the consequence that at the point x=0 (at the wall), and with no ion emission from the wall, J/sub w/=0, there are no ions with a zero velocity component v/sub x/.

36424 Kinetics of the electron distribution in a plasma in an electric field. Reshetnyak, S.A.; Shelepin, L.A. (P. N. Lebedev Physics Institute, Academy of Sciences of the USSR, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **3**: No. 4, 483-486(Jul 1977).

The dynamics of the electron distribution function responding to an abrupt change in the electric field applied to the plasma is analyzed. The analysis is carried out by a new method based on a power-series expansion of an evolution operator which acts on the equilibrium distribution function. A calculation is carried out for the relaxation equilibrium distribution upon the rapid imposition and rapid removal of an electric field.

36425 Helically symmetric equilibrium of current-carrying finite beta plasma. Ohasa, K.; Hamada, Y.; Fujiwara, M.; Miyamoto, K. (Nagoya Univ. (Japan). Inst. of Plasma Physics). *Jpn. J. Appl. Phys.;* **16**: No. 4, 617-621(Apr 1977).

The characteristics of the helically symmetric equilibrium of a longitudinal current-carrying finite beta plasma are studied analytically. An analytical expression of the rotational transform angle indicates that the contribution due to the helical component of the plasma current must be taken into account in addition to the term for the external helical winding and the term for the longitudinal plasma current. The term for the helical component of the plasma current is not always negligible.

36426 Microstructures (clumps) in turbulent plasmas. Balescu, R. (Brussels Univ. (Belgium)); Misguich, J.H. (Association Euratom-CEA sur la Fusion, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). *J. Phys. (Paris), Colloq.;* No. 3, C.209-C.211(1977). (In French).

From National congress on plasma physics; Paris, France (6 - 10 Dec 1976).

A general analysis of binary correlations in a turbulent plasma leads to a functional relation relating correlations to the one-particle distribution function. Such a relation allows to understand the mechanism of generation of the microstructures or clumps introduced by Dupree. The expressions introduced by this author appear as a lowest approximation of the general equation. The features and interpretation of these microstructures are briefly discussed.

36427 Transport properties of partially ionized gases. Capitelli, M. *J. Phys. (Paris), Colloq.;* No. 3, C.227-C.237(1977).

From National congress on plasma physics; Paris, France (6 - 10 Dec 1976).

The main problems arising in the calculation of transport coefficients of partially ionized gases are discussed. Particular attention is given to the convergence of the Chapman-Enskog method, to the influence of electron-atom, ion-atom and ion-ion interactions and of the electronically excited states in affecting the transport properties of a plasma. The bulk of results refer to LTE plasmas, even though some non equilibrium effects are taken into account. The accuracy of available tabulations is then discussed and an application of present results to a problem of plasmachemistry interest is finally presented.

36428 Random phase and resonant broadening approximation in weakly turbulent plasmas. Pesme, D.; Laval, G.; Pellat, R. (Ecole Polytechnique, 91 - Palaiseau (France)). *J. Phys. (Paris), Colloq.;* No. 3, C.213-C.224(1977). (In French).

From National congress on plasma physics; Paris, France (6 - 10 Dec 1976).

Stochastic equations are studied as a model describing weak tubulence. The evolutions are given by Dyson and Bethe-Salpeter equations. In the purely temporal case, the validity conditions of the so-called Bourret approximation is proved. Next, the space and time case is considered with the two following problems: i) the quasi-linear theory: when the electric field is considered as externally given, and in the frame of the weak turbulence theory no divergence and no secular term occur; moreover the resonance broadening terms cannot be self-consistently retained at this order of the theory. On the other hand, these terms appear without any renormalization in the study of the correlation function and are identified to non linear Landau damping. ii) Parametric instabilities in the presence of turbulence. In this problem, the validity conditions of the Bourret approximation are established in the space and time case. This approximation is not always valid, whatever small the correlation time. The usual Random-phase equations are also precisely established. The behavior of the waves is then shown to be either coherent or incoherent depending on the type of the instability. For absolute instability a significant difference is also found.

36429 Turbulence in Tokamaks. Samain, A. (Association Euratom-CEA sur la Fusion, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). *J. Phys. (Paris), Colloq.;* No. 3, C.171-C.176(1977). (In French).

From National congress on plasma physics; Paris, France (6 - 10 Dec 1976).

The transport coefficients in Tokamaks cannot be explained by Coulomb collisions only, and a turbulence must be present to produce these coefficients. Such a turbulence could consist of drift waves, which induce density fluctuations which have been effectively detected through the diffusion of microwaves. The heat flux which may be calculated from the experimental data seems however to be small compared to the flux which results from the energy balance of the plasma. Another type of turbulence which has been observed experimentally consists of the disruptions which tend to flatten the temperature profile on each side of specific magnetic surfaces. These disruptions are responsible for a significant part of the heat flux in the central region of the plasma. From the experimental data, the disruptions appear to be due to a transient radial connection of the flux lines.

36430 About a class of solutions of MHD equations in the machine of tokamak type. Marcilhacy, G. (Paris-6 Univ., 75 (France). Inst. Henri Poincare). *Lett. Nuovo Cim.;* **15**: No. 13, 471-476(27 Mar 1976).

The letter considers the magentohydrodynamic (MHD) equations describing the equilibrium states of a plasma confined by a magnetic field in a machine of tokamak type. Simple confining

analytic solutions of MHD equations are looked for in toroidal coordinates in consideration of their adequacy for the geometry of physics-set problems.

PLASMA PRODUCTION

36431 Submillimeter-laser-induced air breakdown. Woskoboinikow, P.; Mulligan, W.J.; Praddaude, H.C.; Cohn, D.R. (Francis Bitter National Magnet Laboratory, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Appl. Phys. Lett.;* **32**: No. 9, 527-529(1 May 1978).

We report the first demonstration of laser-induced air breakdown at submillimeter wavelengths. An optically pumped D_2O oscillator-amplifier laser system which produced 75-ns pulses at the megawatt level on the 385- and 359-μm transitions was used. Focusing the 10-cm-diam laser beam with a 20- or 38-cm-focal-length mirror onto an arbitrary surface to produce initial ionization caused multiple air breakdown plasmas with a threshold on the order of 1 MW cm^{-2}. Theoretical $(\omega^2+\nu^2)/\nu$ scaling from the ruby and the neodymium laser air breakdown thresholds, where ω is the laser angular frequency and ν is the electron-molecule collision frequency, is in agreement with this initial experimental result.

36432 Ultradense reproducible Z-pinch suitable for CO_2 laser-pellet simulation experiments. Steel, D.G.; Rockett, P.D.; Bach, D.R.; Colestock, P.L. (The University of Michigan, Ann Arbor, Michigan 48109). *Rev. Sci. Instrum.;* **49**: No. 4, 456-459(Apr 1978).

The design and operating characteristics of a unique reproducible linear, high-density ($>10^{19}$ e^-/cm^3), low-temperature ($17<T/sub\ e/<30$ eV) helium Z-pinch are presented in this paper. It is shown that the temperature and critical density scale length (70-200 μm) of the pinched plasma are favorable for simulating CO_2 laser-pellet experiments. Focused CO_2 laser intensities of 10^{12} W/cm^2 result in $v_0/v/sub\ th/\approx 2.8$ at the critical layer, where v_0 is the quiver velocity of an electron in the laser electric field and v/sub th/ is the electron thermal velocity.

36433 Lanthanum hexaboride hollow cathode for dense plasma production. Goebel, D.M.; Crow, J.T.; Forrester, A.T. (Department of Electrical Sciences and Department of Physics, University of California, Los Angeles, California 90024). *Rev. Sci. Instrum.;* **49**: No. 4, 469-472(Apr 1978).

A hollow tube cathode using lanthanum hexaboride as the electron emitter has been designed and constructed. Tests in both argon and hydrogen indicate that this cathode is capable of producing over 800 A of electron current continuously, corresponding to over 25 A/cm^2 from the LaB_6. The cathode has been operated for over 300 h and exposed to air more than 100 times with no deterioration in emission. Projected lifetime is in excess of 3500 h for the sintered LaB_6 piece tested in this configuration. Construction details, performance characteristics, and discussions of space charge limits on emission are described.

36434 Gain-verification problem in extreme ultraviolet lasing. Elton, R.C.; Dixon, R.H. (Naval Research Laboratory, Washington, D. C. 20375). *Opt. Lett.;* **2**: No. 4, 100-102(Apr 1978).

The verification of grain on extreme ultraviolet ion lines in elongated plasmas using optically thin intercombination lines from similar ions is proposed. New impurity-line identifications in laser-produced plasmas suggest that recent reports of gain at 58.23 A may be inconclusive.

36435 Measurements of high-energy deuterons in the plasma-focus device. Gullickson, R.L.; Sahlin, H.L. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *J. Appl. Phys.;* **49**: No. 3, 1099-1105(Mar 1978).

Nuclear activation techniques have been used to measure the fluence of high-energy deuterons in a plasma-focus device. Substantial activation of carbon and aluminum targets was observed on most shots where the deuterium pressure was less than 3 Torr. Carbon activation indicates more than 10^{15} deuterons above 330 keV on some high-intensity shots. These deuterons are strongly forward directed with 0° to 90° ratios exceeding 10^4 on high-yield shots. Ratios of ^{13}N to ^{28}Al, foil-stack activation measurements, and neutron time of flight all consistently show some deuterons have energies above 2 MeV. Measured $^{13}N/^{28}Al$ ratios also indicate more than 10^{12} deuterons of energy greater than 5 MeV, but this result has not been verified by an independent threshold-activation measurement. These measurements illustrate that the plasma-focus device can be operated in two distinctly different modes, with low-pressure operation resulting in the acceleration of ions and electrons to many times the capacitor-bank charging voltage. Most of the neutron emission in low-pressure operation may come from beam-target reactions.

36436 Duration of the source of the current in laser-produced plasmas. Drouet, M.G. (Direction Sciences de base, Institut de recherche de l'Hydro-Quebec, Varennes, Quebec, Canada). *Phys. Lett., A;* **63**: No. 2, 99-100(31 Oct 1977).

The source of the current in a plasma produced by a 1.7 ns CO_2 laser irradiation of a copper target is found to last for up to 150 ns. Evidence is shown for a short circuit in the laser plasma which shields the target from the intense magnetic field associated with the current.

36437 Processes for electronless plasma generation. Avrillier, S.; Schermann, J.P. (Paris-13 Univ., 93 - Saint-Denis (France)). *J. Phys. (Paris);* **38**: No. 8, 913-914(Aug 1977). (In French).

An electron-free plasma can be created, either directly by a pair-formation process, or by adding electronegative particles to a conventional plasma. After the different ion-pair formation and recombination processes are reviewed, the experimental properties of an electron-free plasma and of a negative ion-rich plasma obtained by electron attachment are compared.

36438 Experimental study of an air plasma generated by interaction of a CO_2 laser beam with a solid target. Bournot, P.; Autric, M.; Dufresne, D.; Caressa, J.; Pincosy, P. (Institut de Mecanique des Fluides, 13 - Marseille (France)). *Rev. Phys. Appl.;* **12**: No. 8, 1139-1142(Aug 1977). (In French).

From National congress on plasma physics; Paris, France (6 Dec 1976).

A plane target in air is irradiated by a CO_2 laser beam which is focused sufficiently to produce a laser flux from 10^7 to 1.5×10^8 W cm^{-2} at the surface. Emission and spectral absorption results describe the state of the plasma created on the target. The continued deposition of the laser energy to this plasma finally results in a movement upstream from the surface. Measurements related to this motion are presented.

36439 Kinetic energy of laser accelerated charged particles in a plasma and the possibility of pair production. Schwarz, H.; Tabensky, R. (Brasilia Univ. (Brazil). Departamento de Fisica). *Rikagaku Kenkyusho Hokoku;* **4**: No. 4, 302-320(Mar 1977).

From U.S.-Japan seminar on laser interaction with matter; New York, USA (1 - 5 Nov 1976).

An exact solution of the general equation of motion of charged particles in a medium of refractive index n subjected to irradiation of electromagnetic waves at any intensity and frequency is given. No approximations are necessary even for the relativistic case. Linearly polarized as well as circularly polarized waves are considered. Self-induced fields due to the generated charged particle currents have very little influence on the solutions, especially at higher intensities, where electron-positron pair production can be expected.

PLASMA INSTABILITIES

REFER ALSO TO CITATION(S) 36376, 36395

36440 Magnetohydrodynamic spectrum of instabilities due to plasma rotation. Spies, G.O. (Courant Institute of Mathematical Sciences, New York University, New York, New York 10012). *Phys. Fluids;* **21**: No. 4, 580-587(Apr 1978).

The spectrum of frequencies and growth rates of the linearized magnetohydrodynamic motion about rotating straight theta pinch equilibria is investigated. A qualitative picture is obtained of the distribution of eigenvalues in the complex plane, and of their dependence on equilibrium parameters and the three mode numbers. A numerical procedure is described which uses this picture for computing the eigenvalue with any given triple of mode numbers. It is shown that rigidly rotating equilibria are unstable unless the mass density is an increasing function of radius; computations indicate that rotation shear (within practical limits) cannot stabilize confined equilibria.

36441 Nonlinear transport instability in a diffusive plasma. Sato, T. (Geophysics Research Laboratory, University of Tokyo, Tokyo 113, Japan). *Phys. Fluids;* **21**: No. 4, 600-608(Apr 1978).

Fine structures of the unstable waves and the electron density profiles resulting from nonlinear spatial transport are studied numerically for a collisional flute mode instability. It is confirmed that the nonlinear transport produces regular pulse trains in both the electron density and wave amplitude profiles in the direction perpendicular to the electron drift (in the direction of the density gradient). Fourier spectral analysis of the nonlinear structure in that direction indicates two major spectral peaks. The main peak is the fundamental mode which leads to overall flattening of the density distribution in the entire unstable region. The second peak corresponds to the generated small-scale pulses resulting from a nonlinear instability associated with a strong wave-induced transport. In the steady state the pulses tend to merge and be smeared out to form a plateau in the density profile. These indicate the presence of two different, steady and pulsative, transports. Examination of the spatial structure finds that the pulse width is roughly the same size as the dominant wavelength of the primary wave which propagates in the direction of the drift. It is further found that the observed nonlinear mode can be explained by a nonlinear transport equation of the form $n/sub\ t/+(n^2)/sub\ z/$

+k/sub y/$^{-2}$(n^2)/sub zzz/=0, where k/sub y/ is the wavelength of the dominant primary wave propagating in the direction of the drift and z denotes the coordinate perpendicular to the drift.

36442 Current driven weak ion acoustic turbulence in a magnetized plasma. Bitter, M.; Paris, P.J. (Centre de Recherches en Physique des Plasmas, Ecole Polytechnique Federale de Lausanne, CH-1007 Lausanne, Switzerland). *Phys. Fluids;* **21**: No. 4, 609-616(Apr 1978).

The current driven ion acoustic instability has been studied in a quiescent magnetized argon plasma for electron densities in the range from 10^{10} to 10^{11} cm^{-3}, an electron temperature T/sub e/ of 2.2 eV, an electron-ion temperature ratio T/sub e//T/sub i/ of 15, a homogeneous magnetic field of 400 G, and neutral gas pressures in the range from 1 x 10^{-3} to 5 x 10^{-3} mm Hg. Coulomb collisions are important for these experimental conditions. The instability occurs for dc currents in the range from 100 to 600 mA. The saturation appears to be explained by electron trapping. The nature of the instability is identified from measurements of the cross power density spectrum and the characteristic parameters like electron drift velocity, collisional damping, electron temperature, and electron-ion temperature ratio are determined precisely from an observation of low frequency ion acoustic test waves using an unperturbative method of microwave interometry.

36443 Numerical simulations of collisionless drift instabilities for low-density plasmas. Lee, W.W.; Kuo, Y.Y.; Okuda, H. (Princeton University, Plasma Physics Laboratory, Princeton, New Jersey 08540). *Phys. Fluids;* **21**: No. 4, 617-626(Apr 1978).

Nonlinear behavior of the collisionless drift instabilities are studied for the universal and current driven modes by means of electrostatic particle simulations in two-and-a-half dimensions. Realistic mass ratios of electrons to the ions are used in the simulations, where the guiding-center approximation for the electrons and the exact dynamics for the ions are employed. Several nonlinear effects including the quasi-linear diffusion of the particle density, the frequency shift due to the ambipolar field, the mode competition among the unstable waves, and the quasi-linear diffusion in the velocity space are found to be dominant mechanisms for the saturation. The stabilization of the collisionless drift instabilities by the magnetic shear has also been studied.

36444 Effects of cross-sectional elongation on trapped electron modes. Chu, K.R.; Ott, E.; Manheimer, W.M. (Science Applications, Incorporated, McLean, Virginia 22101). *Phys. Fluids;* **21**: No. 4, 664-668(Apr 1978).

The dispersion relation for the trapped electron mode in noncircular cross-section tokamaks is formulated and evaluated. It is shown that modest reductions in the growth rate result from cross-sectional elongation.

36445 (ORNL/tr—4610) **Review of instability theory for high pressure tokamak plasma.** Mikhailovskii, A.B.; Kurchatov, I.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). Apr 1978. Translation by L. Kobylenski of USSR report. 48p. Dep. NTIS, PC A03/MF A01.

This paper reviews the instability theory for a tokamak with high pressure plasma. The review consists of the following sections: (1) introduction and history, (2) role of the nonhydromagnetic part of the perturbed pressure in nonpotential (electromagnetic) instabilities, (3) the shear effect on nonpotential instabilities, (4) nonpotential trapped particle modes, (5) the role of magnetic confinement of resonant particles in nonpotential instabilities, (6) quasi-odd Alfven modes, (7) short wavelength nonpotential instabilities, (8) nonpotential instabilities of a streaming plasma of high pressure with inhomogeneous velocity profile, (9) drift effects in the MHD mode theory for a tokamak, (10) several problems of the theory of flute instability and the resistive g mode, (11) conclusion.

36446 Suppression of ω/sub c i/ instability in a mirror-confined plasma by injection of an electron beam. Klinkowstein, R.E.; Smullin, L.D. (Research Laboratory of Electronics and Plasma Fusion Center, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Phys. Rev. Lett.;* **40**: No. 12, 771-773(20 Mar 1978).

A hot ion plasma (E/sub i perpendicular/ $\cong$ 400 eV, n $\cong$ 10^{13} cm^{-3}) is trapped in a minimum-B mirror system. A strong instability at ω/sub c i/ is observed for neutral densities $< 10^{11}$ cm^{-3}. We have observed the suppression of this instability when an electron beam ($>$ or = 42 kW) is injected into the plasma. We believe the suppression is due to a population of hot electrons produced and trapped in the mirror by the beam-plasma interaction.

36447 Optimum discharge parameters for beam-plasma ion sources. Conrad, J.R. (Nuclear Engineering Department, University of Wisconsin, Madison, Wisconsin 53706). *J. Appl. Phys.;* **49**: No. 3, 1283(Mar 1978).

An expression for the optimum discharge parameters of beam-plasma ion sources is obtained and compared with experimental data.

36448 Electromagnetic instability in counterstreaming collisional plasmas in a magnetic field. Lee, K.F. (Chinese Univ. of Hong Kong, Shatin). *IEEE Trans. Plasma Sci.;* **PS-5**: No. 4, 216-222(Dec 1977).

The stability of low frequency electromagnetic waves is studied for collisional, counterstreaming plasmas situated in a steady magnetic field. Based on the cold fluid equations, it is found that obliquely propagating waves are unstable when the parallel component of the phase velocity is smaller than the electron streaming velocity. The frequency of the instability is of the order of but always smaller than the ion cyclotron frequency. The growth rate is proportional to the electron-ion collisional frequency.

36449 Stabilization of counter streaming electron beam instability. Okutsu, E.; Itakura, A. (Tokyo Univ. of Education (Japan). Faculty of Science). *Phys. Lett., A;* **63**: No. 2, 109-111(31 Oct 1977).

Instability at half the electron cyclotron frequency that arises in a system of symmetrical counter streaming electron beams is stabilized by the injection of a third beam.

36450 Parametric instabilities produced by a relativistic electron beam in a plasma. Baikov, I.S. (Stichting voor Fundamenteel Onderzoek der Materie, Amsterdam (Netherlands). Instituut voor Atoom en Molecuulfysica). *Physica, B, C;* **92**: No. 2, 267-280(Oct 1977).

The parametric instability driven by the primary spectrum of the hydrodynamic two-stream instability produced by a relativistic electron beam in a plasma is investigated. The saturated level of the primary wave electric field is determined by electron trapping in the potential well of the wave or by the quasilinear beam relaxation process. After saturation, the primary wave collapses by way of the oscillating two-stream instability. The cases of the strong and weak primary electric field in comparison with the thermal energy of a plasma are considered. For a strong field the growth rates of the parametric instability and plasma heating due to the latter are found. Ion heating is not significant in comparison with electron heating (approximately as the cube root of the mass ratio). In a weak field the parametric oscillating two-stream spectrum of saturation is found. In the one-dimensional case this spectrum of electric field energy fluctuations varies as k^{-2} if the fluctuation field exceeds the threshold pump electric field for the oscillating two-stream instability. For the weak field plasma heating rate is found. Since the energy transfer is via Landau damping, the particle heating is characterized by the formation of high-energy tails on the distribution function.

36451 Microinstabilities in the plasma focus. Schoenbach, K.; Krompholz, H.; Michel, L.; Herziger, G. (Technische Hochschule Darmstadt (Germany, F.R.)). *Phys. Lett., A;* **62**: No. 6, 430-432(19 Sep 1977).

Experimentally observed suprathermal microwave emission correlated to soft x-rays emitted with high anisotropy are indicating the existence of current driven microinstabilities in the plasma focus.

36452 Parametric absorption of laser radiation in a nonisothermal plasma. Bychenkov, V.Y.; Silin, V.P.; Tikhonchuk, V.T. (P. N. Lebedev Physics Institute, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **26**: No. 4, 197-199(20 Aug 1977).

The roles that the dimension of the parametric-instability region and the finite width of the longitudinal plasma oscillations play in the anomalous absorption of radiation by a plasma is explained.

36453 Effect of ion viscosity on shear stabilization of drift dissipative instability. Voitsenya, V.S.; Voloshko, A.Y.; Solodovchenko, S.I.; Shtan', A.F. (Physicotechnical Institute, Ukrainian Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **26**: No. 4, 220-222(20 Aug 1977).

The influence of the ion mass on the stabilization of drift oscillations by shear was investigated in a toroidal l=3 stellarator. A threshold shear value that depends on M/sub i/ and starting with which a strong suppression of the oscillations sets in has been observed. It is shown that the drift oscillation level in the entire range of shear variation is smaller the larger the ion mass.

36454 Mode transition process in collisional drift waves and self-consistent plasma diffusion across a magnetic field. Jones, R. (General Atomic Co., San Diego, Calif. (USA)). *Can. J. Phys.;* **55**: No. 15, 1356-1359(1 Aug 1977).

Drift wave induced cross field plasma transport is observed to destabilize new drift instabilities which then act to quench the original linear mode and enhance diffusion.

36455 Ionization instability of a plasma in a laser field. Nastoyashchii, A.F. (I. V. Kurchatov Institute of Atomic Energy, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **3**: No. 4, 425-428(Jul 1977).

The stability of the ionization state in a plasma heated by a laser pulse is discussed. Under certain conditions, an instability can occur in the plasma and lead to the breakup of the plasma into separate layers with different temperatures (and with different ion charges). Simple models are adopted to determine the instability boundaries and the growth rate of the perturbations. Nonlinear

solutions of the corresponding one-dimensional problem for the temperature distribution (and for the ionization distribution) in the unstable plasma are studied.

36456 Plasma-wave collapse in a magnetic field. Krasnosel'skikh, V.V.; Sotnikov, V.I. (Institute of Cosmic Studies, Academy of Sciences of the USSR). *Sov. J. Plasma Phys. (Engl. Transl.);* **3**: No. 4, 491-495(Jul 1977).

The modulational instability of plasma waves in a magnetic field is analyzed in both the linear and nonlinear stages. The linear theory shows that the instability occurs in a small angular cone in a strong magnetic field. As a result, cavities filled with plasma waves form, having the shape of pancakes compressed along the direction of the pump wave. If the pump wave is directed along the magnetic field, there can be a collapse of these cavities, which leads to an explosive increase in the field and in the amplitude of the density variation in the cavity.

36457 Perturbation growth rates associated with current disruption in a tokamak. Arsenin, V.V. (I. V. Kurchatov Institute of Atomic Energy, Moscow). *Sov. J. Plasma Phys. (Engl. Transl.);* **3**: No. 4, 524-525(Jul 1977).

It is pointed out that the disruptive instabilities observed in Tokamaks can be explained in terms of classical "fast" MHD instability.

36458 Diffusion of a multi-ion species plasma due to drift wave fluctuations. Tange, T.; Nishikawa, K. (Hiroshima Univ. (Japan). Faculty of Science); Itoh, K.; Inoue, S. *J. Phys. Soc. Jpn.;* **42**: No. 6, 2006-2013(Jun 1977).

A general theory is presented for the diffusion of a multi-ion species plasma across magnetic field due to electrostatic fluctuations. It is shown that the diffusion flux due to wave-particle interactions is not necessarily proportional to the density gradient of the particle species of interest. The result is applied to the impurity diffusion due to those drift waves which exist in a single ion-species plasma. The dominant nonlinear effect is the induced scattering of waves on ions and the resulting diffusion constant of the host ions is given by the Kadomtsev formula, d -- γ^2/kappa$^2\omega$, where γ, ω and kappa are respectively the growth rate, frequency and wavenumber of the drift wave. The impurity diffusion constant is positive (or negative) if the impurity Larmour radius is smaller (or greater) than the host-ion Larmour radius, and becomes greater than the host diffusion constant if the spectrum is localized to the unstable region.

36459 Parametric instabilities in magnetized plasma. Sanuki, H.; Schmidt, G. (Nagoya Univ. (Japan). Inst. of Plasma Physics). *J. Phys. Soc. Jpn.;* **42**: No. 2, 664-669(Feb 1977).

The theory of parametric instabilities driven by a finite wavenumber general pump wave is developed for homogeneous magnetized plasma. The pump wave as well as the decay products can be electrostatic as well as electromagnetic. This formalism is applied to describe lower hybrid decay into electromagnetic modes. A separate treatment for the all electrostatic wave case is given using the particle drift equations. In particular the resonant decay instabilities and the oscillating two stream instabilities are studied.

36460 Double resonance parametric excitation due to zero and finite wavenumber pumps. Tanaka, T. (Kyoto Univ. (Japan). Dept. of Physics). *J. Phys. Soc. Jpn.;* **42**: No. 2, 670-679(Feb 1977).

We study parametric instabilities in plasmas driven by both a dipole-field and a finite-wavenumber pumps with high frequencies, their difference being chosen close to a low frequency resonance. General dispersion relations are derived by a general scheme. They are applied to a special case of the pumps of a Langmuir wave and a transparent dipole field. The analysis is limited to the extreme region that ω sub(Pe)k^{2}lambda sub(De)sup(2) >> y, ν, ω sub(Pi)k lambda sub(De), where k is the given wavenumber of the excited low frequency wave, y the growth rate and ν the linear damping rate of the excited Langmuir wave. A lowering of the pump energy is found for the dipole field when ν >> ω sub(Pi) k lambda sub(De), or for one pump when the other pump is near the usual decay instability threshold. The excitations take place most easily in one-dimensional configurations.

36461 Crossfield-current-driven electrostatic instabilities in an inhomogeneous magnetoplasma. Yatsui, K.; Imai, T.; Furumi, M. (Osaka Univ., Toyonaka (Japan). Faculty of Engineering Science). *J. Phys. Soc. Jpn.;* **42**: No. 2, 652-657(Feb 1977).

Dispersion characteristics and numerical results are presented of the crossfield-current-driven electrostatic instabilities in an inhomogeneous magnetoplasma. By use of a two-fluid hydrodynamic model in a cylindrical coordinate involving the effects of finite temperature and density inhomogeneity, we present the corresponding dispersion relation and show that, in the low-frequency range ω^2 << ωsub(ci)sup(2) (ω sub(ci): ion-cyclotron frequency), there exists an instability termed as the modified ion-cyclotron instability. These wave characteristics are clarified in some parameter spaces. Apart from this, some numerical results are also presented of the lower-hybrid instability and the ion-cyclotron harmonic instability, the latter being obtained with a kinetic model in an inhomogeneous hot plasma. The comparison of these results with the experiment is also made especially for the modified ion-cyclotron mode, and it is found that the experimental results are in qualitative agreement with the theoretical prediction.

36462 Possibility of filamentation instability in plasma. Mori, Y.; Maruyama, M.; Takeda, S.; Minami, K. (Nagoya Univ. (Japan). Faculty of Engineering). *J. Phys. Soc. Jpn.;* **42**: No. 2, 658-663(Feb 1977).

The spatial perturbation of plasma density and internal field perpendicular to the direction of propagation are experimentally investigated, when a high-power pulsed microwave is incident on the plasma whose plasma frequency is close to the applied one. For the microwave power above a certain threshold, the electron density and the electric field show a temporally growing perturbation which increases with the incident power. The properties of the perturbation, including its growth rate, are discussed and compared with the theory for the filamentation instability.

36463 Effects of finite pump bandwidth on the parametric-decay instability. Obenschain, S.P. Los Angeles; Univ. of California (1977). 122p. University Microfilms Order No. 77-16,194.

Thesis (Ph. D.).

The feasibility of using finite pump bandwidth to control parametric instability in a plasma is examined experimentally. With two distinctively different experimental arrangements, we study the effects of finite bandwidth pumps on the parametric decay instability. In the first experiment, the parametric decay instability is excited electrostatically by means of grids immersed in a low density plasma. We present experimental results on the effects of finite pump bandwidth on the threshold power, growth, saturation level, and spectral structure of the instability produced plasma waves. We find that as the pump bandwidth approaches and exceeds the instability resonance width, the instability is inhibited. In a second experiment, the instability is excited by high power microwaves launched by a gridded horn into a near critical density plasma. Here we have investigated the effects of finite pump bandwidth on the production of nonthermal hot electrons by parametric instability. We find that with sufficient pump bandwidth, the hot electron production is reduced or eliminated.

36464 Stabilization of interchange modes in a multiple mirror plasma. Riordan, J.C. Berkeley, CA; Univ. of California (1976). 108p. University Microfilms Order No. 77-15,835.

Thesis (Ph. D.).

Interchange instabilities in a plasma confined by a periodic magnetic mirror field are theoretically stabilized by a minimum-average-B well, which can be created by superposing a quadrupole field upon the mirror field. The arbitrary magnetic field is expanded to fourth power in radius and the depth and radial extent of the well are calculated. Variational and heuristic techniques are used to determine field shapes which optimize various well parameters. A simple, realistic coil geometry is given for a minimum-average-B well applicable to multiple mirror fusion reactors. The stabilization of interchange modes was investigated experimentally with a thermal lithium plasma confined by a periodic magnetic mirror field with adjustable curvature. As the destabilizing curvature was reduced, the transverse velocity of the m = 1 mode was observed to decrease substantially. The stabilization was greater than that predicted by curvature reduction alone; an explanation in terms of line-tying is presented. The stabilization of higher order modes by finite Larmor orbit effects was observed to be less than theoretically predicted; destabilization of the modes by incomplete line-tying is suggested.

36465 Thermonuclear instabilities of a plasma. Belikov, V.S.; Kolesnichenko, Ya.I.; Orayevskii, V.N. pp 56-64 of Probl. teorii plazmy. Kiev; Naukova Dumka Press (1976). (In Russian)

A review of work dedicated to instabilities related to the occurrence of thermonuclear reactions in a plasma. Thermonuclear instabilities resulting from the thermodynamic deviation from equilibrium of the distribution function of the products of the thermonuclear reaction are analyzed. The study of stability is performed using analysis of the dielectric permeability tensor for a plasma containing high energy alpha particles. Conditions of development of thermonuclear instabilities are determined. It is emphasized that one of the most essential characteristics is the ratio of critical density of alpha particles to plasma density. For the thermonuclear problem, we are interested only in instabilities which may develop in a rather dense plasma with $\beta = 8\ \pi p/B^2$ approximately greater than 0.1. Therefore, it is natural to classify instabilities on the basis of parameter β. The Alfven instability, instability of a heterogeneous plasma at frequencies near the plasma ion frequency, excitation by products of the thermonuclear reaction of fast magnetosonic waves and whistles are analyzed in sequence. Cyclotron magnetosonic instability is discussed, as well as the excitation of instability in a low pressure plasma by high energy ions. The result of low frequency instability is

slight turbulization of the plasma. The turbulent fluxes which develop in this case are analyzed. 19 references.

36466 Low frequency parametric plasma instabilities. Kitsenko, A.B.; Stepanov, K.N. pp 320-329 of Probl. teorii plazmy. Kiev; Naukova Dumka Press (1976). (In Russian)

A review is presented of theoretical results on the investigation of low-frequency parametric instabilities in a plasma in the following frequency ranges: (1) lower hybrid resonance; (2) cyclotron ion frequency; (3) magnetohydrodynamic areas; (4) the area of magnetic pumping ω_0 approximately k parallel v/sub T//sub i/ much less than ω/sub B//sub i/, where ω_0, ω/sub B//sub I, k parallel, v/sub T//sub i/ the pumping frequency, ion gyrofrequency, longitudinal wave number and thermal velocity of ions respectively. Dispersion equations and expressions for instability increments are presented. A comparison is made with experimental data. 38 references.

PLASMA WAVE PHENOMENA

36467 (GA-A—14785) Whistler cavity eigenmodes in tokamaks. Chu, C.; Sperling, J.L. (General Atomic Co., San Diego, Calif. (USA)). Dec 1977. Contract EY-76-C-03-0167-038. 4p. (CONF-780113—4). Dep. NTIS, PC A02/MF A01.

From 3. conference on RF plasma heating; Pasadena, CA, USA (11 Jan 1978).

The propagation properties of whistler waves in a tokamak are discussed. It is shown that for the lower-hybrid range of frequencies, the wave can be a cavity eigenmode in present day tokamaks. In order to optimize the heating deep within the plasma, it is desirable to excite those modes which have the largest possible wave number parallel to the magnetic field for a given frequency. It is also shown that plasma heating by whistler cavity eigenmodes will probably be dominated by nonlinear processes.

36468 (IPPJ—274) Observation of current-driven ion sound wave in a turbulently heated plasma (THE MACH II). Amagishi, Y.; Iguchi, H.; Ito, Y.; Kawabe, T.; Mase, A. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Jan 1977. 15p. Dep. NTIS (US Sales Only), PC A02/MF A01.

Dynamic behaviors of the turbulence are measured in a turbulently heated plasma by microwave scattering method. Scattered signals are observed at the time before the plasma becomes resistive. The phase velocity of the wave increases with time. The value of the phase velocity is found to be consistent with that of the ion sound wave propagating across the magnetic field, when the increase of the phase velocity is interpreted as due to the increase of the electron temperature.

36469 Effect of density fluctuations on lower hybrid resonance cone propagation. Bellan, P.M.; Wong, K.L. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *Phys. Fluids;* **21**: No. 4, 592-599(Apr 1978).

Experimental measurements show that coherent, azimuthal density fluctuations (1) focus lower hybrid resonance cones azimuthally, and (2) modulate the radial location of the resonance cones. A simple theory based on wave refraction is presented; this theory is in good agreement with the experimental observations. The theory is extended to give a physical description of wave propagation through turbulent, isotropic (perpendicular to B) noise such as has been observed in tokamaks; it is found that the turbulence causes the lower hybrid wave vectors to have an angular spread in the plane perpendicular to B.

36470 Soluble theory of nonlinear beam-plasma interaction. Mynick, H.E.; Kaufman, A.N. (Department of Physics and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Fluids;* **21**: No. 4, 653-663(Apr 1978).

A soluble theory of the post-saturation portion of a beam-plasma interaction is developed, concentrating on explaining the results of O'Neil, Winfrey, and Malmberg. Analytic progress is made possible by applying a certain constraint procedure, characterized by the "rotating-bar" approximation, to a Hamiltonian formulation of the problem. The procedure yields, from the original N-particle Hamiltonian H, a new, reduced Hamiltonian H, which has only two particle-related degrees of freedom, and which maintains the conservation laws of energy and momentum possessed by H. The equations of motion coming from H still describe the self-consistent interaction of a mode of the plasma with the beam particles, as opposed to previous work, and, because of the great reduction in the number of degrees of freedom, explicit expressions for the nonlinear frequency shift, and growth rate, of the mode can be obtained, which are in very good agreement with the simulation results of O'Neil, Winfrey, and Malmberg.

36471 Whistler wave ducting caused by antenna actions. Sugai, H.; Maruyama, M.; Sato, M.; Takeda, S. (Department of Electrical Engineering, Nagoya University, Nagoya, Japan). *Phys. Fluids;* **21**: No. 4, 690-694(Apr 1978).

Whistler waves launched from an antenna damp away for small incident power. With increasing power, undamped nondiverging waves (the ducted waves) are observed, together with a field-aligned density trough and electron heating. However, the density trough is found not only in the wave propagation regime (ω/ω/sub c/$<$1), but also in the wave evanescence regime (ω/ω/sub c/$>$1). This implies that the density depression is mainly created by the effect of the antenna near-zone field rather than by the wave radiation pressure. The intense localized field near the antenna gives rise to electron heating which leads to the density trough. The ducting of antenna-launched whistler waves has been explained as a filamentation instability in terms of nonlinear wave-plasma interactions.

36472 Internal wave solitons. Meiss, J.D.; Pereira, N. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Phys. Fluids;* **21**: No. 4, 700-702(Apr 1978).

A numerical solution of the Benjamin-Ono equation for internal waves shows soliton behavior. Two and three Lorentzian solitons pass through one another unscathed. An initial Lorentzian with larger than soliton amplitude decays into solitons, with velocities predicted by the five conservation laws.

36473 Spectrum of axisymmetric torsional Alfven waves. Sy, W.N. (School of Physical Sciences, The Flinders University of South Australia, Bedford Park, South Australia, 5042, Australia). *Phys. Fluids;* **21**: No. 4, 702-704(Apr 1978).

The spectrum of axisymmetric torsional Alfven waves propagating in a cylindrical, nonuniform, resistive plasma waveguide has been analyzed by a method of singular perturbations. It is indicated why some experiments show a continuous spectrum and others a discrete spectrum.

36474 Nonlinear theory of drift waves in multispecies plasma. Gillet, C.; Rogister, A. (Institut fuer Plasmaphysik der Kernforschungsanlage JuelichGmbH, 5170 Juelich, Federal Republic of Germany). *Phys. Fluids;* **21**: No. 4, 704-705(Apr 1978).

The saturation level of drift waves in a multispecies plasma is estimated. The convection rate of each species across the plasma is calculated.

36475 Theoretical interpretation of angle- and polarization-dependent laser light absorption measurements. Thomson, J.J.; Kruer, W.L.; Langdon, A.B.; Max, C.E.; Mead, W.C. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Fluids;* **21**: No. 4, 707-708(Apr 1978).

It is shown that recently published observations of angle- and polarization-dependent absorption of intense laser light are consistent with computer simulations of resonance absorption in a steepened plasma profile, with the additional assumption of a modestly rippled critical surface.

36476 Double-layer forward shocks in a magnetohydrodynamic fluid. Tajima, T.; Leboeuf, J.N.; Dawson, J.M. (Department of Physics, University of California, Los Angeles, California 90024). *Phys. Rev. Lett.;* **40**: No. 10, 652-656(6 Mar 1978).

We have observed forward-facing slow wave shocks created by an obstacle in a magnetohydrodynamic flow in runs on a magnetohydrodynamic particle stimulation code. The shocks have a double-layer structure composed of the compressive and accompanying rarefactive slow-wave fronts.

36477 Self-focusing of a non-Gaussian laser mode in a dense plasma. Nayyar, V.P. (Department of Physics, Punjabi University, Patiala-147002, India). *J. Appl. Phys.;* **49**: No. 3, 1114-1118(Mar 1978).

This paper presents a study of the self-focusing of a high-power non-Gaussian laser beam operating in TEM_{01} mode in a strongly ionized plasma. The nonlinearity in the dielectric constant is caused by the nonuniform redistribution of carriers due to their inhomogeneous heating by the laser beam having transverse variation of intensity along its wave front. It is found that when the power of the beam exceeds the critical power, focusing effects are observed in the Y direction, whereas divergence of the beam takes place in the X direction. In the reverse case (when P$<$P/sub cr/) the normalized beam-width parameter f_2 first increases in the Y direction, after penetrating a certain depth it reaches a broadened maxima and then starts decreasing with the distance of propagation inside the medium. The beam continues diverging in the X direction. It has also been found that absorption brings about a reduction in the extent of self-focusing. When the absorption length is less than the self-focusing length appreciable self-focusing does not take place.

36478 Resonant decay of finite-extent cold-electron plasma waves. Wong, K.L.; Bellan, P.; Porkolab, M. (Princeton Plasma Physics Laboratory, Princeton, New Jersey 08540). *Phys. Rev. Lett.;* **40**: No. 9, 554-557(27 Feb 1978).

The parametric decay of a finite-extent cold-electron plasma wave (slow wave) was studied experimentally. Using a frequency of $\omega_0 >$ or $\approx 10\omega$/sub π/, it was found that the decay wave propagated along the pump wave rather than in the E_0 x B direction. This is

in agreement with the recent theoretical predictions of finite-length stabilization.

36479 Quasi-linear WKB kinetic theory for nonplanar waves in a nonhomogeneous warm plasma 1. Transverse waves propagating along axisymmetric B_0. Hollweg, J.V. (Max-Planck-Institut fuer Aeronomie, 3411 Katlenburg-Lindau, Federal Republic of Germany). *J. Geophys. Res.;* **83**: No. A2, 563-574(1 Feb 1978).

A new set of quasi-linear kinetic equations is presented for transverse waves propagating along an axisymmetric magnetic field configuration. A WKB expansion is used to include effects of nonhomogeneity and nonplanarity of the waves. The equations allow simultaneous calculation of the spatial (and temporal) evolution of wave power spectra and the spatial (and temporal) evolution of particle distribution functions, including for the first time important wave-particle interactions which depend explicitly on the nonplanarity of the waves and the nonhomogeneity of the plasma and fields. The usefulness of the equations is demonstrated for a cold plasma, where a number of new results for wave propagation and acceleration of the plasma have been obtained. Along the way, a new quasi-linear separation of the average distribution function has been introduced, the usefulness of which is demonstrated by comparison with fluid theory. The principal new results are briefly summarized in section 6 of the paper.

36480 Stability of obliquely modulated Langmuir waves in collisional plasmas. Sharma, A.S.; Buti, B. (Physical Research Lab., Ahmedabad, India). *IEEE Trans. Plasma Sci.;* **PS-5**: No. 4, 293-296(Dec 1977).

The effects of collisions and oblique modulation on Langmuir waves are studied. The nonlinear Schroedinger equation for these waves are derived by using the Krylov-Bogoliubov-Mitropolsky method. The collisions damp the envelope of these waves and the obliqueness of the modulation affects the dispersion of the system. The Langmuir waves are found to modulationally stable as in the collisionless and parallel modulation case. However, the width of the envelope hole state of these waves is found to increase due to the oblique modulation.

36481 Nonlinear standing langmuir waves. Tang, T.W. (Univ. of Massachusetts, Amherst); Motz, H. *IEEE Trans. Plasma Sci.;* **PS-5**: No. 4, 297-300(Dec 1977).

The structure of stationary nonlinear standing Langmuir waves is examined in a self-consistent manner. A singularity for the stationary wave function is found which may cause the Langmuir waves to collapse, or expand indefinitely.

36482 Quenching of the plasma oscillation in the counter stream type beam-plasma interaction. Amemiya, H. (Institute of Physical and Chemical Research, Wako, Saitama (Japan)). *Phys. Lett., A;* **63**: No. 2, 103-104(31 Oct 1977).

It is shown experimentally that quenching by an external wave of a natural oscillation in the electron beam-plasma interaction of counter stream type occurs at discrete frequencies resonantly, where the velocity distribution function of beam electrons does not change substantially.

36483 Observation of spatial wave echoes at the lower hybrid mode. Leppert, H.D.; Lammers, B.; Wiesemann, K.; Mori, I.; Schlueter, H. (Bochum Univ. (Germany, F.R.). Inst. fuer Experimentalphysik 2). *Phys. Lett., A;* **62**: No. 7, 501-503(3 Oct 1977).

The existence of wave echoes in the lower hybrid region has been verified experimentally. Spatial wave echoes of second and third order are observed to obey theoretical expectations.

36484 Note on the Korteweg—De Vries equation for the propagation of fast ion-acoustic waves in multi-dimensions. Prasad, P.; Krishnan, E.V. (Indian Inst. of Science, Bangalore. Dept. of Applied Mathematics). *Phys. Lett., A;* **62**: No. 7, 483-484(3 Oct 1977).

The authors apply the technique of Prasad and Ravindran to the derivation of a multidimensional Korteweg—De Vries equation for ion-acoustic waves in a collisionless plasma. Some slips and omissions made by Tagare, in his derivation of the equations for this problem, are pointed out.

36485 Simple model of non-linear beam-plasma interaction. Sedlacek, Z. (Ceskoslovenska Akademie Ved, Prague. Ustav Fyziky Plazmatu). *Phys. Lett., A;* **62**: No. 7, 490-492(3 Oct 1977).

A microscopic Lagrangian and Hamiltonian is derived for the waves on a beam-plasma system with the reaction of the waves on the background self-consistently taken into account. Numerical integration of the corresponding canonical equations confirms that even a model of only several degrees of freedom suffices to describe the basic non-linear phenomena of beam-plasma interaction.

36486 Propagation and reflection of lower hybrid waves launched by slow waveguiding circuits. Tanaka, S.; Terumichi, Y.; Fukushima, M.; Nishitani, S. (Kyoto Univ. (Japan). Dept. of Physics). *Phys. Lett., A;* **62**: No. 7, 472-474(3 Oct 1977).

Using finite length, modified slow waveguiding circuits, cold lower hybrid waves can be made to propagate in one or two ways along the axial direction, corresponding to the $\pi/2$- or π-modes characteristic for these periodic structures. On reflection at a metal wall, phase reversal is demonstrated.

36487 Self-reflection of intense electromagnetic waves in plasmas. Tewari, D.P.; Kumar, A.; Sharma, J.K. (Indian Inst. of Tech., New Delhi. Dept. of Physics). *Appl. Phys.;* **14**: No. 2, 225-227(Oct 1977).

A uniform electromagnetic wave of high power density, propagating in a collisional plasma gives rise to a modification in temperature-dependent collision frequency and in turn induces a gradient in the complex refractive index of the medium. A WKB solution of the problem predicts a backward propagating wave on account of the self-induced inhomogeneity. The amplitude of the backward (i.e. reflected) wave increases with increasing power density of the wave. This is a volume nonlinear effect and is appreciable for usually employed power densities.

36488 Strongly non-linear transverse envelope solitons. Baumgaertel, K. (Zentralinstitut fuer Elektronenphysik, Berlin (German Democratic Republic)); Zchakaja, D. (AN Gruzinskoj SSR, Tbilisi. Inst. Fiziki). *Phys. Lett., A;* **62**: No. 6, 400-402(19 Sep 1977).

Solitary wave solutions of the coupled equations for transverse high frequency waves and the low frequency ion motion (equations of continuity and momentum) are investigated.

36489 Excitation of coherent electromagnetic radiation by a relativistic electron beam in a plasma surrounded by a metal wall. Ivanov, S.T. *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 9, 1043-1044(Sep 1977).

The interaction of a relativistic electron beam with a plasma surrounded by a metal wall is analyzed. It is shown that coherent electromagnetic radiation can be excited in a strongly magnetized plasma. The excitation is of a resonant nature and occurs over a narrow range of plasma parameters. The efficiency with which the kinetic energy of the beam is converted into electromagnetic radiation is higher than without a wall.

36490 Conversion of a Gaussian beam in an inhomogeneous plasma. Arsaev, I.E.; Starokon', V.I. (All-Union Scientific-Research Institute of Physicotechnical and Radiotechnical Measurements, Mendeleevo). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 9, 1062-1066(Sep 1977).

Equations are derived in the paraxial approximation for the properties of a Gaussian beam that propagates through a radially inhomogeneous plasma. As an example that approximates several experimental situations, it is shown that the "refractive" effect has an important influence on the beam properties in an inhomogeneous medium, as compared with the situation in free space. The damping and phase shift of the wave due to the plasma are derived and used in calculations in the geometric approximation. These calculations incorporate the "refraction" of the Gaussian beam in the inhomogeneous medium.

36491 Spatial distribution of microwave fields and polarization of the visible emission from a beam—plasma discharge. Busygin, E.P.; Vlasenko, S.I.; Grigor'yants, V.G.; Popovich, V.P. (A. F. Ioffe Physicotechnical Institute, Academy of Sciences of the USSR, Leningrad). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 9, 1095-1097(Sep 1977).

Analysis of the data in the literature shows that the distribution of the electrons interacting with the rf fields in a beam—plasma discharge should be anisotropic. Experiments show that the anisotropic distribution of fast electrons is manifested in the polarization of the visible emission from a helium discharge.

36492 Stability and kinetic effects of a standing Langmuir wave. Pavlenko, V.P.; Petviashvili, V.I. (Institute of Nuclear Research, Ukrainian Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **26**: No. 4, 200-202(20 Aug 1977).

A standing Langmuir wave (or an infinite chain of synchronous standing solitons in the one-dimensional case) is stable and can be continuously fed by an electron beam. The interaction produces humps on the beam velocity distribution function.

36493 Effectiveness of interaction between an electron beam having large ν/γ and a preheated flat target. Gribkov, V.A.; Dubrovskii, A.V.; Isakov, A.I.; Kozlova, T.A.; Krokhin, O.N.; Nikulin, V.Y.; Semenov, O.G.; Sklizkov, G.V. (P. N. Lebedev Physics Institute, USSR Academy of Sciences). *JETP Lett. (USSR) (Engl. Transl.);* **26**: No. 4, 209-214(20 Aug 1977).

It is shown that the absorption of a relativistic electron beam of density 10^{13} W/cm^2 exceeds the classical absorption when the beam interacts with a preheated plasma.

36494 Interaction of coherent waves with MHD turbulence. Pimenov, S.F.; Sinitsyn, Y.A. (Institute of Radiophysics and Electronics, Academy of Sciences of the Ukrainian SSR). *Sov. J. Plasma Phys. (Engl. Transl.);* **3**: No. 4, 455-460(Jul 1977).

The interaction of coherent waves with Kolmogorov-type turbulence is treated in the MHD approximation. A self-consistent system of equations consisting of the dynamic equation for the waves and equations of a kinetic type describing the turbulence is derived. This approach permits the interaction of the coherent waves with the turbulence to be calculated in a unified manner to lowest order in the interaction in the linear approximation with respect to the wave amplitude. The equations are used to calculate the damping rates for long waves which are interacting with a Kolmogorov turbulence.

36495 Nonlinear penetration of electromagnetic waves into a semi-infinite magnetized plasma. Pavlenko, V.N.; Revenchuk, S.M. (Institute of Physics, Academy of Sciences of the Ukrainian SSR). *Sov. J. Plasma Phys. (Engl. Transl.);* **3**: No. 4, 460-464(Jul 1977).

The penetration of electromagnetic waves due to their nonlinear interaction into a semi-infinite magnetized plasma (a constant and homogeneous magnetic field is directed perpendiular to the plane plasma boundary) is treated in the kinetic approximation. The case in which the waves are propagating along the normal to the plasma boundary is treated. It is found that two electromagnetic waves, with frequencies ω_1 and ω_2, incident on the plasma excite nonlinear longitudinal waves in the plasma at the sum and difference frequencies, $\omega=\omega_2 +- \omega_1$. A study is made of the case in which the frequencies ω_1 and ω_2 lie in the band corresponding to resonant electron-cyclotron absorption and in which the nonlinear longitudinal waves at the sum and difference frequencies are slightly damped plasma waves and ion—acoustic waves, respectively. The case which is most interesting from the plasma-heating standpoint is that in which nonlinear longitudinal ion—acoustic waves are excited. These waves transfer energy to the plasma ions.

36496 Transmission of electromagnetic waves through a plasma slab produced by a moving ionization source. Semenova, V.I. (Scientific-Research Radiophysics Institute, Gor'kii). *Sov. J. Plasma Phys. (Engl. Transl.);* **3**: No. 4, 465-468(Jul 1977).

A study is made of the interaction of electromagnetic waves with a time-varying plasma slab of finite thickness. This slab is produced by a moving ionization source in a gas which is at rest. The static magnetic field excited at the ionization front as the electrons are driven by the incident wave reradiates energy into the electromagnetic wave in the course of the plasma relaxation caused by recombination processes. As a result, an electromagnetic wave of finite amplitude can propagate beyond a time varying slab of an "opaque" plasma (ω/sub p/$^2>>\omega$/sub inc//sup(^{0})^2). This result distinguishes this case from the case of a moving steady-state plasma with the same properties.

36497 Effect of ionization relaxation on wave propagation in a low-temperature plasma. Kogan, E.Y.; Mal'nev, V.N. (T. G. Shevchenko State University, Kiev). *Sov. J. Plasma Phys. (Engl. Transl.);* **3**: No. 4, 481-483(Jul 1977).

As waves propagate in a plasma with a low degree of ionization, the shift of the ionization equilibrium in the wave leads to a relaxation of the ionization degree of freedom in accordance with the perturbed plasma properties. The irreversibility of this process leads to a corresponding wave damping. This damping is studied for ion—acoustic waves and the drift—dissipative mode.

36498 Parametric excitation of longitudinal waves by the transverse—longitudinal field established by two microwaves in a plasma. Suender, D.; Tskhakaya, D.D. (Institute of Physics, Academy of Sciences of the Georgian SSR, Tbilisi). *Sov. J. Plasma Phys. (Engl. Transl.);* **3**: No. 4, 487-491(Jul 1977).

The effect of two external microwaves at frequencies ω_1, $\omega_2>>\omega$/sub Le/ on a plasma is analyzed. One of the microwaves is assumed much weaker than the other ($E_2=\kappa E_1$, κvery-much-less-than1), and the difference frequency ω/sub -/$=\omega_2$: ω_1 is assumed much smaller than both ω_2 and ω_1. The Lorentz magnetic force due to the transverse microwaves creates a stimulated longitudinal field with a frequency ω/sub -/. Under certain conditions this longitudinal component of the pump field in the plasma can lead to an amplification of longitudinal resonant plasma waves which is more efficient than that caused by the transverse microwave field. The wave growth rate and the threshold modulation depth, $\kappa=\kappa_0$, are derived.

36499 Temporal echo in a plasma in a strong rf electric field. Aliev, Y.M.; Gradov, O.M.; Nazaryan, A.K. (Erevan State University). *Sov. J. Plasma Phys. (Engl. Transl.);* **3**: No. 4, 523-524(Jul 1977).

It is shown that an outside electric field can have a decisive effect on the shape of a echo signal in a homogeneous plasma.

36500 Ion Bernstein wave in an ion beam-plasma system. Takeda, M.; Idehara, T.; Ishida, Y. (Fukui Univ. (Japan). Faculty of Engineering). *J. Phys. Soc. Jpn.;* **42**: No. 5, 1737-1743(May 1977).

The dispersion relation of ion Bernstein wave is analyzed numerically, for a Maxwellian plasma and an ion beam—plasma system. In an ion beam—plasma system, the coupling of the wave with the slow space charge wave and the slow cyclotron wave results in electrostatic instabilities, while those with the fast space charge wave and the fast cyclotron wave do in strong damping of waves. The behaviors of the wave are studied in detail for both cases of a Maxwellian plasma and an ion beam—plasma system, the results of which are compared with the electron Bernstein wave.

36501 Resonant three-wave interactions of density waves in a self-gravitating disk. Ikeuchi, S. (Kyoto Univ. (Japan). Dept. of Physics). *Prog. Theor. Phys. (Kyoto);* **57**: No. 4, 1239-1254(Apr 1977).

As a nonlinear behavior of density wave in a self-gravitating disk, resonant three-wave processes are discussed. For both cases of the hydrodynamical and the Vlasov description of the disk, the resonance condition and the coupling coefficients of parametric interactions are calculated. When the wave duration time is so small, the steady propagation of triple solitary pulses is expected. The conditions for this mode are examined for a disk-like galaxy and the soliton model of spiral arms is discussed.

36502 Observation of nonlinear Landau damping of electrostatic waves in an electron beam-plasma system. Sugaya, R.; Sugawa, M.; Nomoto, H. (Ehime Univ., Matsuyama (Japan). Faculty of Science). *J. Phys. Soc. Jpn.;* **42**: No. 4, 1373-1381(Apr 1977).

The nonlinear Landau damping and growth of electrostatic waves in an electron beam-plasma system in a magnetic field have been observed experimentally. The space charge wave of the beam decays nonlinearly into the Trivelpiece-Gould mode, satisfying the resonant condition ω_0-ω_1-(kappa sub(parallel 0)-kappa sub(parallel 1))v sub(b)=mω sub(c) (m is an integer). This decayed wave can be amplified exponentially by increasing the amplitude of the pump wave. Similarly, an externally launched small amplitude test wave, having the same frequency as the decayed wave, can be amplified at the comparable rate. The nonlinear Landau damping coupling coefficients measured experimentally are in good agreement with theory. The virtual wave has also been observed. The pump wave amplitude decays strongly by the presence of the large amplitude test wave.

36503 Three-dimensional parametric decay of a Langmuir wave into another Langmuir and a longitudinal low frequency waves. II. Tanaka, T. (Kyoto Univ. (Japan). Dept. of Physics). *J. Phys. Soc. Jpn.;* **42**: No. 4, 1355-1361(Apr 1977).

A three-dimensional parametric decay is theoretically investigated of a Langmuir wave with a given finite wavenumber K into another Langmuir wave and a longitudinal low frequency wave. In this paper we study such an extreme case as $y + \gamma$, ωsub(i)K lambda sub(e)$<<\omega$sub(e)K^{2}lambda sub(e)sup(2), where y is the growth rate of the excited waves, γ the damping rate of the excited Langmuir wave ωsub(e) the electron plasma frequency, ωsub(i) the ion plasma frequency and lambda sub(e) the electron Debye length, respectively. To this end, a model equation describing the parametric coupling of nearly free resonance type is studied under less restrictive condition than the usual theory. It is shown that the Langmuir wave with almost the same wavenumber is excited most easily and propagates in the opposite direction to that of the pump wave.

36504 Sandia Laboratories: particle beam fusion research. Freeman, J.R.; Goldstein, S.A.; Hadley, G.R.; Johnson, D.L.; Martin, T.H. (Sandia Labs., Albuquerque, N.Mex. (USA)). *Rikagaku Kenkyusho Hokoku;* **4**: No. 4, 270-277(Mar 1977).

From U.S.-Japan seminar on laser interaction with matter; New York, USA (1 - 5 Nov 1976).

A review of Sandia Laboratories' program to investigate the feasibility of achieving inertial confinement fusion using pulsed power technology to produce focused electron and ion beams is presented. Recent results are discussed, including beam focusing, target interaction studies, and accelerator development.

36505 Nonlinear modulation of spatial waves in a steady plasma flow. Ikuta, T. (Nagoya Univ. (Japan). Dept. of Physics). *J. Phys. Soc. Jpn.;* **42**: No. 2, 694-699(Feb 1977).

Nonlinear modulation of strongly dispersive ion-acoustic standing waves produced by some obstacle in a uniform plasma flow, is investigated by means of the reductive perturbation method. The two fluid equations composed of cold ions and isothermal electrons are used, which in the specific ranges of Mach number and wavenumber permit the spatial waves. Consequently, the system is reduced to the nonlinear Schroedinger equation expressed in terms of three independent variables which are responsible for slow two-dimensional spatial variation and slower temporal change. It is further shown that in general the nonlinear Schroedinger equation derived from the Korteweg-de Vries equation is always stable as to the modulational instability.

36506 Reflection of high power pulsed microwave incident on a plasma. Mori, Y.; Maruyama, M.; Takeda, S. (Nagoya Univ. (Japan). Faculty of Engineering). *J. Phys. Soc. Jpn.;* **42**: No. 2, 680-683(Feb 1977).

A high power microwave of 9 GHz with pulse width of 2.9 μ sec is incident on a plasma with the electron density of 10^{12} cm^{-3} at a pressure of 10^{-4} Torr in an Argon gas. For the various powers of the incident microwave, the temporal reflection powers are measured at

the electron densities close to the cut-off value of the microwave. The reflection is found first to decrease and increase again with the increased incident power. This is not expected from the linear theory for cold plasmas. These abnormal behaviors can be explained by the existing theories.

36507 Three-dimensional parametric decay of a Langmuir wave into another Langmuir and a longitudinal low frequency waves, 1. Tanaka, T. (Kyoto Univ. (Japan). Dept. of Physics). *J. Phys. Soc. Jpn.;* **42**: No. 2, 644-651(Feb 1977).

A three-dimensional parametric decay is theoretically studied of a pump Langmuir wave with a given finite wavenumber K into a longitudinal low frequency wave with an ajustable wavenumber k and another Langmuir wave. In this paper we study an extreme case; $y+\gamma >> \omega_{sub(e)} K^2 lambda\ sub(e) sup(2)$ where y is the growth rate of the excited waves, γ the linear damping rate of the excited Langmuir wave and $\omega_{sub(e)}$ the Langmuir frequency. It is shown that the pump energy well above the threshold takes a minimum at a wavenumber satisfying $k >> K$. However, the minimum of the pump energy just above the threshold is attained when k -- O(K) or when $k >> K$, according mainly to the strength and the wavenumber of the pump. In particular when k -- O(K), the maximum growth is realized when the three wave-vectors form a certain triangle, satisfying the wavevector conservation law.

36508 Reflection of a transient electromagnetic wave by a magnetized plasma with loss of half space. Jinno, K.; Kojima, T. (Osaka Univ., Suita (Japan). Faculty of Engineering). *Desalination;* **60**: No. 1, 40-46(Jan 1977). (In Japanese).

The transient response of reflection of the electromagnetic pulse waves coming into magnetized plasma with loss of half space, on which an external static magnetic field parallel to the boundary surface was applied, was studied. A method of numerical integration was applied to obtain the reflection waves when impulsive plane electromagnetic waves come in vertically. The reflection waves when sinusoidal form waves come vertically into the anisotropic plasma without loss was obtained by the numerical calculation of convolution integration. As the results of analysis, the effects of loss and static magnetic field on the reflected waves were seen. The effect of external static field was large, and the increase of loss reduced the amplitude of the transient response. The reflected waves appeared as the superposed waves of those with the frequencies equivalent to two cut-off frequencies to abnormal waves. When external static field was strong, the amplitude of the reflected waves was reduced.

36509 Linear and nonlinear development of a lower-hybrid wave driven by a perpendicular ion beam. Seiler, S.W. Princeton, NJ; Princeton Univ. (1977). 79p. University Microfilms Order No. 77-21,476.

Thesis (Ph. D.).

A lower-hybrid instability with ion cyclotron harmonics is observed to be driven by the perpendicular velocity component of an injected ion beam. In the uniform magnetic field of a Q device the beam follows a helical path coaxial with the isothermal target plasma. The frequency spectrum [ω approximately equal to (ω/sub pi/^{2} + ω/sub ci/^{2})/sup $^1/_2$/], azimuthal propagation (ω/k approximately equal to u/sub b perpendicular/), and growth rate (γ approximately ω/sub ci/) of the instability are all in good agreement with a numerical calculation based on warm-plasma theory. Pulsed beams are used to follow the instability from the linearly growing stage to nonlinear saturation. By varying the beam parameters, a transition of the nonlinear saturation mechanism from the quasilinear to the trapping regime is demonstrated. The enhanced perpendicular momentum loss of the beam ions is examined by using a fast-response energy analyzer and by measuring the resultant beam orbit modifications; both the real and velocity space diffusion are in agreement with nonlinear theory. Finally, the relevance of these results to neutral beam injection in fusion devices is discussed.

36510 Formation of envelope solitons in magnetized plasmas. Spatschek, K.H. (Essen Univ. (Gesamthochschule) (Germany, F.R.)). *Lett. Nuovo Cim.;* **15**: No. 14, 519-522(3 Apr 1976).

Soliton solutions in magnetized plasmas are considered. The purpose of the letter is to derive the explicit form of the nonlinear Schroedinger equation describing the nonlinear development of the wave amplitude, in magnetized plasmas by a simple method based on results known from the theory of linear parameter instabilities. The procedure allows a study of a new type of upper hybrid solutions not previously reported.

36511 Fast wave resonances near the ion cyclotron frequency. Dollinger, R.E. Lubbock, TX; Texas Tech. Univ. (1976). 77p. University Microfilms Order No. 77-16,027.

Thesis (Ph. D.).

Wave damping has been observed for the fast (compressional) wave at frequencies that are about 10% above the second and the third harmonics of the ion cyclotron frequency. It is shown theoretically that this 10% frequency shift can be explained as a result of collisions. The theory also relates the width of the resonance to a collision frequency. The waves were launched by a one turn loop around the cylindrical plasma column and damped in a magnetic beach. The current in this one turn loop came from a 1 kW, 5.2 MHz oscillator. The waves were monitored by another one turn loop that was axially displaced from the first loop. The plasma was produced from a 5 mTorr initial filling of deuterium or hydrogen gas by special pre-ionization which was followed by an axial current from a ringing capacitive discharge (Q approximately equal to 5, f approximately equal to 400 kHz). At the end of this axial discharge, when the waves were monitored, the highly ionized plasma had a temperature of about 2 eV and a density of about 2.5 x $10^{20}/m^3$. The wave damping measurements are reported in a series of graphs of wave magnitude versus the background magnetic field. The magneto-sonic column resonance up through the second radial mode was also observed. A summary of various "pre-ionization" and "turbulent heating" schemes which were investigated as plasma sources is also presented.

36512 Theory of nonlinear plasma oscillations of finite amplitude. Akhiezer, A.I.; Demutskiy, V.P.; Polovin, R.V. pp 166-167 of Probl. teorii plazmy. Kiev; Naukova Dumka Press (1976). (In Russian)

A report is presented on the theoretical results of the study of the stability of nonlinear stable Langmuir waves in an isotropic plasma. A nonlinear dispersion equation is presented and it is determined that if $delta^2\ \omega/delta\ k^2)(delta\ \omega/delta\ a^2) > 0$, the oscillations are stable (ω, k and a are the frequency, wave number and amplitude of the wave, respectively.)

FUSION POWER PLANT TECHNOLOGY

36513 (ANL/FPP—77-2) **Fusion Power Program quarterly progress report, April—June 1977.** Stacey, W.M. Jr.; Darby, J.B. Jr.; Harkness, S.D. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 101p. Dep. NTIS, PC A06/MF A01.

Separate abstracts were prepared for four of the included sections. (MOW)

36514 (ANL/FPP—77-2, pp 37-49) **Experimental power reactor.** 1977.

In Fusion Power Program quarterly progress report, April—June 1977.

The following five topics are discussed using figures and diagrams: (1) energy storage and transfer program, (2) thermomechanical analysis, (3) a steam dual-cycle power conversion system for the EPR, (4) EPR tritium facility scoping studies, and (5) vacuum systems. (EPR)

36515 Tokamak fusion power reactors. Stacey, W.M. Jr.; Abdou, M.A. (Argonne National Lab., IL). *Nucl. Technol.;* **37**: No. 1, 29-39(Jan 1978).

The major parameters and corresponding economic characteristics of a representative class of commercial tokamak fusion power reactors are examined as a function of four major design parameters: plasma β/sub t/, toroidal magnetic field strength, first-wall lifetime, and power output. It is shown that for β/sub t/ equal to or greater than 0.06, the minimum cost of energy is obtained for toroidal field strengths of approximately 8 to 9 T. Tokamak power plants exhibit an economy of scaling with a lower cost of energy for larger power reactors. Representative design parameters, costs, schedule, and technology advances are presented for a sequence of three reactors that could lead to the demonstration of commercial feasibility of this class of tokamak fusion power reactors near the turn of the century.

36516 Breeder control fusion reactor. Topical interview. Schlueter, A. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). *Umsch. Wiss. Tech.;* **77**: No. 17, 559-560(Sep 1977). (In German).

The energy sources of the future are extremely controversial. The consumption of fossil fuel shall decrease during the next decades, because exhaustion of the resources, pollution, increase of CO_2 in the atmosphere and other reasons. But at present the question it not yet settled which alternative energy system should replace the fossil fuel. First of all nuclear energy in the form of fission reactions seems to come into operation to a larger extent. The next step may be the controlled thermonuclear fusion reaction. Furthermore, a comparison between fusion and fission is given which shows that fusion would bring about less risks than the breeders. An advantage of the fusion reactor would be the fact that the fuel cycle is closed. Unfortunately, the physical questions are not as yet satisfactorily clarified so that one cannot be sure whether a fusion reactor can really be built.

36517 Observation of REB acceleration accompanied with beam focusing. Takagi, K. (Nagoya Univ. (Japan). Faculty of Engineer-

ing); Kubota, Y.; Miyahara, A. *Jpn. J. Appl. Phys.;* **16**: No. 3, 537-538(Mar 1977).

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36518 Cost sensitivity analysis of possible fusion power plants. Buende, R. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). *Atomkernenergie;* **30**: No. 3, 183-191(1977).

A reference design was used in preparing a mathematical model of a fusion power plant with a tokamak reactor to investigate the extent to which the uncertainty still inherent in the physical reactor parameters affects the power costs. While only limited reductions of the power costs are achieved by improvements of the reference values for the reactor burn time, power density in the torus and load on the first wall, the power costs rise in keeping with the extent to which these parameters fall short of the reference values. As the results obtained in present-day experiments are still well below the reference values, a great deal of effort is still required in the fields of plasma physics and materials research to achieve an economically operating fusion power plant.

36519 JET project. Huguet, M. (UKAEA Research Group, Abingdon. Culham Lab.). *J. Phys. (Paris), Colloq.;* No. 3, C.155-C.160(1977). (In French).

From National congress on plasma physics; Paris, France (6 Dec 1976).

The JET project (Joint European Torus) is the more important project in the European Community program for controlled fusion. It is a Tokamak device. Its chief parameters are reviewed, the machine and auxiliary system performance are described. The design stage having been completed the machine construction is now planned. The experimental program is discussed in the framework of the JET organization.

36520 Technical aspects of a thermonuclear reactor with magnetic confinement. Leloup, C. (Association Euratom-CEA sur la Fusion, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). *J. Phys. (Paris), Colloq.;* No. 3, C.33-C.42(1977). (In French).

From National congress on plasma physics; Paris, France (6 Dec 1976).

After some generalities on fusion reactor, a comparison is given between several system studies. Then, the divertor, the blanket, the magnets, and radiation damages on materials are discussed.

36521 Research on fusion in the European Community. Palumbo, D. (Commission of the European Communities, Brussels (Belgium)). *J. Phys. (Paris), Colloq.;* No. 3, C.1-C.7(1977). (In French).

From National congress on plasma physics; Paris, France (6 Dec 1976).

The organization of the thermonuclear fusion research inside the European Community is described. The physical purpose and present program (tokamaks, reversed pinches, stellarators, heating and injection and high density plasmas) are recalled together with the long-term program (the Jet, and fusion reactors) in view of the physical and economical requirements.

36522 Device for generation, confinement, and heating of the hot plasma in magnetic mirror reflex discharges. Popovici, C. (Institutul Central de Fizica, Bucharest); Mateescu, I.; Moldovan, I.; Balaceanu, M.; Ionescu; Rotileanu, P.; Coatu, S.; Golovanov, N.; Stoian, M. *Stud. Cercet. Fiz.;* **29**: No. 6, 595-603(1977). (In Rumanian).

A device for the study of a hot plasma in magnetic mirror field is presented. The device permits to achieve pulsed discharges of kilovolts and currents of amperes in a magnetic mirror field with Bmax approximately equal to 7 k gauss. Different parts which assure the automatization, teleoperation and electronic control are described.

36523 Construction of non-circular cross-section tokamak with diverter 'JFT-2a' for nuclear fusion research. Itou, Y.; Imura, Y.; Hashimoto, H.; Kazawa, Y. (Hitachi Ltd., Ibaraki (Japan). Hitachi Works). *Hitachi Hyoron;* **58**: No. 10, 813-818(Oct 1976). (In Japanese).

The Tokamak, JFT-2a, with tear drop like cross section was constructed at JAERI by Hitachi Ltd. It has an axisymmetric diverter, and is now serving as a precious tool for the study of diverters. This report outlines the concept of this machine and some technical problems associated with each major component. The design specifications are shortly described in the first section, and compared with the Tokamaks with a diverter (PDX and ASDEX) in other countries. The remaining sections of this report are devoted to the description on the design of each component and the associated technical problems. Vacuum vessel, shell and auxiliary shell, limiter, diverter hoop, and troidal coil are discussed in some detail. The distributions of stress and displacement of the troidal coil were analyzed by the finite-element method. The results are shown in a figure. Other components such as vertical field coil, current converter, vacuum system, electric source, and control system are also shortly described.

36524 Current state of controlled nuclear fusion. Rabinovich, M.S. (AN SSSR, Moscow. Fizicheskij Inst.). *Beitr. Plasmaphys.;* **16**: No. 6, 353-367(1976). (In German).

The modern state of stationary thermonuclear reactor development based on tokamaks is reviewed. Unsolved tokamak mystery (pseudoclassical electron thermoconductivity, disruptive instability, impurities transport, instability due to trapped ions) as well as parameter selection principles of future devices for break-even in the USSR, USA, West Europe, and Japan and CTR problems solution to the end of this century are discussed.

BLANKET ENGINEERING

36525 (ANL/FPP—77-2, pp 58-79) **Fusion systems engineering.** 1977.

In Fusion Power Program quarterly progress report, April—June 1977.

Information is given on each of the following topics: (1) fusion reactor systems studies, (2) development of blanket processing technology for fusion reactors, (3) safety studies of CTR concepts, and (4) cross section measurements and techniques. (MOW)

36526 (CONF-770802—10) **Thermal hydraulic and power cycle analysis of liquid lithium blanket designs.** Misra, B.; Stevens, H.C.; Maroni, V.A. (Argonne National Lab., Ill. (USA)). 1977. Contract W-31-109-ENG-38. 11p. Dep. NTIS, PC A02/MF A01.

From National heat transfer conference; Atlantic City, NJ, USA (15 Aug 1977).

Thermal hydraulic and power cycle analyses were performed for the first-wall and blanket systems of tokamak-type fusion reactors under a typical set of design and operating conditions. The analytical results for lithium-cooled blanket cells show that with stainless steel as construction material and with no divertor present, the maximum allowable neutron wall loading is approximately 2 MW/m^2 and is limited by thermal stress criteria. With vanadium alloy as construction material and no divertor present, the maximum allowable neutron wall loading is approximately 8 MW/m^2 and is limited by an interplay of constraints imposed on the maximum allowable structural temperature and the minimum allowable coolant inlet temperature. With a divertor these wall loadings can be increased by from 40 to 90 percent. The cost of the vanadium system is found to be competitive with the stainless steel system because of the higher allowable structural temperatures and concomitant higher thermal efficiencies afforded by the vanadium alloys.

36527 (EUR-CEA-FC—891) **Numerical evaluation of the ion energy balance in a Tokamak. Application to Petula.** Bernard, M. (Association Euratom-CEA sur la Fusion, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). Apr 1977. 33p. (In French). Dep. NTIS (US Sales Only), PC A03/MF A01.

The quasi-stationary equilibrium of the ions of a Tokamak discharge is investigated. This problem is studied independently from the equilibrium of electrons which is supposed to be known. The geometry is cylindrical with only a radial dependence, and all quantities are time-independent. This work takes into account the presence of neutral gas atoms and of several impurities such as carbon, oxygen, aluminium, iron, molybdenum and tungsten. Impurities follow locally the coronal model. Application of additional R-F heating of the ions has been considered, in particular TTMP heating. The energy balance of the ions takes the form of a nonlinear second order differential equation in T(i) (ion temperature) which is numerically integrated. The code which is then obtained is applied to the experimental situations studied or planned on the PETULA machine.

36528 Effect of magnetic perturbations on divertor scrape-off width. Boozer, A.H.; Rechester, A.B. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *Phys. Fluids;* **21**: No. 4, 682-689(Apr 1978).

A general method is developed for calculating the width, due to magnetic perturbations, of the scrape-off layer of a tokamak with a divertor. The method, which assumes the plasma particles are tied to the field lines, should provide a good estimate provided the predicted width is large compared to that given by particle diffusion or finite particle drift orbit effects. The general theory is applied to a simple analytic model of a divertor to indicate the expected magnitude of the scrape-off layer thickness.

36529 Neutron heating sensitivity to cross-section variations in a controlled thermonuclear reactor blanket. Arcipiani, B. (CNEN, Rome); Palmiotti, G.; Salvatores, M. *Nucl. Sci. Eng.;* **65**: No. 3, 540-544(Mar 1978).

Neutron heating sensitivities to cross-section uncertainties were calculated in a controlled thermonuclear reactor (CTR) blanket. For this purpose, the well-known generalized perturbation

methods were used. The CTR blanket chosen was representative of current design specifications. Sensitivity profiles were generated for neutron heating in ^{6}Li, ^{7}Li, iron, and niobium to their respective cross sections. Fairly high changes in the neutron heating can be produced by variations in individual cross sections.

36530 Neutronics and photonics calculations for the tokamak experimental power reactor. Santoro, R.T.; Baker, V.C.; Barnes, J.M. (Oak Ridge National Lab., TN). *Nucl. Technol.;* **37**: No. 3, 274-295(Mar 1978).

One-dimensional neutronic and photonic calculations have been carried out using the discrete-ordinates code ANISN to compare the nuclear performance of blanket and shield designs proposed for use in the Tokamak Experimental Power Reactor. The radiation transport was accomplished using cross-section data from the DLC-37 library (ENDF/B-IV). Nuclear heating and radiation damage rates were estimated using the latest available nuclear response functions. The nuclear analysis was performed for both nonbreeding and tritium-breeding blanket modules to compare the spatial variations of the radiation flux and energy distributions, nuclear heating, radiation damage, and tritium breeding. The nonbreeding blanket modules that utilize potassium plus Type 316 stainless steel or potassium only as the neutron and gamma-ray energy absorbing medium, and breeding blanket modules that use natural lithium as the fertile material were also evaluated as a function of the first wall cooling scheme.

36531 Critical impurity concentrations for power multiplication in beam-heated toroidal fusion reactors. Jensen, R.V.; Post, D.E.; Jassby, D.L. (Princeton Univ., NJ). *Nucl. Sci. Eng.;* **65**: No. 2, 282-289(Feb 1978).

Using the most recent evaluations of power loss by impurity radiation, we have calculated the maximum permitted impurity concentration for various species as a function of Q, the ratio of deuterium-tritium (D-T) fusion power to injected beam power. These criteria for maximum impurity concentration must be satisfied before applying the usual n/sub e/tau/sub E/ versus T/sub i/ conditions for obtaining a given Q value. For Q approximately greater than 3, the critical impurity concentration f/sub cz/ varies as Z/sup -2.2 to -2.5/. The tolerable concentration of medium- and high-Z impurities for operation at low Q (approximately less than 2) can be at least one order of magnitude larger than the concentration allowed for ignition, provided that the plasma temperature is maintained by reacting ion beams.

36532 Computational method for neutron transport problems in toroidal geometry. Jung, J. (Argonne National Lab., IL). *Nucl. Sci. Eng.;* **65**: No. 1, 130-140(Jan 1978).

The neutron transport equation in toroidal geometry is numerically solved by making use of the discrete-ordinates S/sub N/ method. The computer program developed for this computation is capable of treating a multigroup problem with anisotropic scattering. Numerical examples are given for the first wall and blanket system of a conceptual tokamak reactor design that has an aspect ratio of approximately 3. To validate the present method, several numerical comparisons have been made with Monte Carlo results as well as with ANISN calculations in the case of an infinite major radius. The toroidal geometry calculation, with a uniform neutron source distribution throughout the plasma region, yields a neutron flux that, at the first wall, is maximum near the top and bottom of the torus. As one moves radially outward from the first wall, the position of the maximum flux rapidly shifts to the outermost point of each poloidal circle, and the flux decreases monotonically along the poloidal circumference until it reaches a minimum at the innermost point of the torus. At approximately 10 cm from the first wall, for examplee, the variation becomes greater than 20%. The one-dimensional infinite cylinder calculation shows an overestimate of flux within thee first 1 cm of the first wall compared to the present calculation. In the rest of the first wall and blanket system, the one-dimensional model underestimates the fluxes in the outer region of the torus and overestimates the fluxes in the inner region.

36533 Tailoring the breeding-fission ratio in a hybrid fusion reactor blanket by neutron moderation with iron. Shani, G. (Ben-Gurion Univ. of the Negev, Beer-Sheva, Israel). *Nucl. Sci. Eng.;* **65**: No. 1, 183-187(Jan 1978).

The hybrid fusion reactor is becoming an interesting and promising model. In the present Note, a method for controlling the breeding-fission ratio is investigated. Since ^{238}U fission occurs mainly with fast neutrons and breeding occurs with intermediate and slow neutrons, an optimal ratio can be obtained by partial slowing down of the original 14.9-MeV neutrons. This is done using iron as the moderator. Uranium samples were irradiated with 14.9-MeV neutrons from a deuterium-tritium reaction with iron layers of various thicknesses betweeen the samples and the neutron source. It was found that with a relatively thin layer of iron (12 cm), any breeding-fission ratio can be obtained within a range of two decades. The breeding rate changes by only 50% when the iron-slab thickness changes from 0 to 12 cm, while the fission rate follows (more or less) the 14-MeV neutron flux and drops by more than two decades. Good agreement was obtained between the measurement and the calculated results.

36534 Monte Carlo analysis of the effects of a blanket-shield penetration on the performance of a tokamak fusion reactor. Santoro, R.T.; Tang, J.S.; Alsmiller, R.G. Jr.; Barnes, J.M. (Oak Ridge National Lab., TN). *Nucl. Technol.;* **37**: No. 1, 65-72(Jan 1978).

Adjoint Monte Carlo calculations have been carried out using the three-dimensional radiation transport code, MORSE, to estimate the nuclear heating and radiation damage in the toroidal field (TF) coils adjacent to a 28- x 68-cm^2 rectangular neutral beam injector duct that passes through the blanket and shield of a deuterium-tritium (D-T) burning tokamak reactor. The plasma region, blanket, shield, and TF coils were represented in cylindrical geometry using the same dimensions and compositions as those of the Experimental Power Reactor. The radiation transport was accomplished using coupled 35-group neutron, 21-group gamma-ray cross sections obtained by collapsing the DLC-37 cross-section library. Nuclear heating rates were obtained using fluence-to-kerma factors generated by the computer codes MACK and SMUG, and radiation damage rates were calculated using damage response functions generated by the computer code RECOIL. The presence of the neutral beam injector duct leads to increases in the nuclear heating rates in the TF coils ranging from a factor of 3 to a factor of 196, depending on the location. Increases in the radiation damage also result in the TF coils. The atomic displacement rates increase by factors of 2 to 138 and the hydrogen and helium gas production rates increase from factors of 11 to 7600 and from 15 to 9700, respectively.

36535 Absolute fission-rate distributions in lithium and hybrid fusion blanket assemblies, (1). Experimental method and results. Maekawa, H.; Seki, Y. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). *J. Nucl. Sci. Technol. (Tokyo);* **14**: No. 2, 97-107(Feb 1977).

Absolute fission-rate distributions in four types of spherical blanket assemblies have been measured by micro-fission chambers embodying ^{232}Th, ^{238}U, ^{237}Np, and ^{235}U. The four types of assemblies were of the lithium-metal and hybrid blanket form, with and without graphite reflector, i.e., Li, Li-C, U-Li and U-Li-C, and were made up by stacking lithium, graphite and natural uranium blocks, in various combinations. The effective outer radii of the spheres composing the assemblies were, in the case of U-Li-C assembly, 3.3, 10.0, 34.1, and 55.3 cm, respectively, for the central cavity, natural uranium, lithium, metal and graphite regions. Absolute measurements demand knowledge of the number of 14-MeV neutrons produced by the accelerator and the number of fissionable atoms present in the chamber wall coating. The neutron yield was estimated from the counts of an α-monitor installed on the accelerator. The fission chambers were calibrated using the same accelerator. The overall experimental errors in most cases did not reach 10%, and averaged about 7%. Most of the neutrons reflected by the graphite possessed energies below 0.3 MeV. The assemblies, when possessed of a natural uranium region, saw a two- to three-fold increase in the number of neutrons.

36536 Nuclear characteristics of D-D fusion reactor blankets, (1). Survey calculation. Nakashima, H.; Ohta, M. (Kyushu Univ., Fukuoka (Japan). Faculty of Engineering); Seki, Y. *J. Nucl. Sci. Technol. (Tokyo);* **14**: No. 2, 75-87(Feb 1977).

Fusion reactors operating on the deuterium (D-D) cycle are considered promising for their freedom from tritium breeding in the blanket. In this paper, neutronic and photonic calculations are undertaken covering several blanket models of the D-D fusion reactor, using presently available data, with a view to comparing the nuclear characteristics of these models, in particular, the nuclear heating rates and their spatial distributions. Nine models are taken up for the study, embodying various combinations of coolant, blanket, structural and reflector materials. About 10 MeV is found to be a typical value for the total nuclear energy deposition per source neutron in the models considered here. The realization of high energy gain is contingent upon finding a favorable combination of blanket composition and configuration. The resulting implications on the thermal design aspect are briefly discussed.

36537 Destruction of magnetic surfaces in a divertor region attributed to a discrete structure of magnetic coils. Tomita, Y.; Momota, H. (Kyoto Univ. (Japan). Faculty of Engineering); Seki, S. *J. Phys. Soc. Jpn.;* **42**: No. 2, 687-693(Feb 1977).

The destruction of magnetic surfaces near a separatrix of a divertor is analyzed. Unperturbed magnetic surfaces formed by a plasma current and a divertor current are assumed. Destruction of magnetic surfaces is attributed to perturbations of magnetic fields, which are assumed to be brought from discrete structure of magnetic coils. Analysis is based on "Stochasticity" and a spread of divertor region is calculated in terms of a ripple of the magnetic field.

36538 Boundary conditions for a fusion plasma. Behrisch, R. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). *J. Phys. (Paris), Colloq.;* No. 3, C.43-C.52(1977).

From National congress on plasma physics; Paris, France (6 - 10 Dec 1976).

The boundary conditions in today's plasma experiments and in later fusion plasmas are determined by the interactions of the plasma with the first solid wall. In today's experiments desorption by the plasma hitting the wall dominates, but ion backscattering, trapping and release, as well as sputtering of wall material, will dominate in machines with cleaner walls. The fluxes to the first wall for some of today's plasma experiments are reported and the data about the elementary processes at the first wall are shortly reviewed.

MAGNET COILS AND FIELDS

REFER ALSO TO CITATION(S) 36568

36539 (COO—4726-3) **Penetration of magnetic fields into plasmas.** Bengtson, R.D. (Texas Univ., Austin (USA)). 1976. Contract EY-76-S-05-4672. 114p. Dep. NTIS, PC A06/MF A01.

A pulsed plasma experiment was constructed to study the penetration of a fast-rising magnetic pulse into an initially unmagnetized, weakly ionized plasma of density 10^{11} to 10^{13} cm^{-3}. Magnetic probe data was analyzed using a magnetohydrodynamic approach to obtain detailed information about the dynamics of the penetration mechanism. In particular it is possible to obtain the local resistivity and thus the collision frequency from this data. These collision frequencies compare favorably with theoretical estimates of turbulent collision frequencies. The data indicates that sufficient energy is absorbed to heat the bulk of the plasma to temeratures in excess of 1 keV. A differential rotation of a collisionless theta-pinch column during implosion has been observed and explained by a model in which the driving mechanism is the off-diagonal element p/sub r theta/ of the pressure tensor. Rotational motion was detected by directional probes and spectroscopic techniques. Experimental data were modeled by a one-dimensional hybrid code which included ionization and charge exchange of protons with neutral H atoms.

36540 (EUR-CEA-FC—821) **Equilibrium field and current determination for Tokamaks.** Aymar, R.; Leloup, C.; Pariente, M. (Association Euratom-CEA sur la Fusion, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). Apr 1977. 165p. Dep. NTIS (US Sales Only), PC A08/MF A01.

The report presents the various methods of calculation and the main results obtained in the determination of equilibrium fields and currents for Tokamak devices. Both circular and non-circular cross-sections are studied; iron core as well as air core transformers are considered.

36541 (WFPS-TME—039) **Cryogenic recovery analysis of forced flow supercritical helium cooled superconductors.** Lee, A.Y. (Westinghouse Electric Corp., Pittsburgh, Pa. (USA). Fusion Power Systems Dept.). Aug 1977. Contract W-7405-ENG-26. 27p. (CONF-770801—26). Dep. NTIS, PC A03/MF A01.

From Cryogenic engineering conference; Boulder, CO, USA (2 Aug 1977).

A coupled heat conduction and fluid flow method of solution was presented for cryogenic stability analysis of cabled composite superconductors of large scale magnetic coils. The coils are cooled by forced flow supercritical helium in parallel flow channels. The coolant flow reduction in one of the channels during the spontaneous recovery transient, after the conductor undergoes a transition from superconducting to resistive, necessitates a parallel channel analysis. A way to simulate the parallel channel analysis is described to calculate the initial channel inlet flow rate required for recovery after a given amount of heat is deposited. The recovery capability of a NbTi plus copper composite superconductor design is analyzed and the results presented. If the hydraulics of the coolant flow is neglected in the recovery analysis, the recovery capability of the superconductor will be over-predicted.

36542 Magnet field system for a high density tokamak reactor. Williams, J.E.C. (Massachusetts Inst. of Tech., Cambridge). *IEEE Trans. Plasma Sci.;* **PS-5**: No. 4, 242-247(Dec 1977).

A design for a magnet system for a high density high field tokamak reactor is described. In this design stress in the trunk of the toroidal field structure is significantly reduced by elimination of the central ohmic heating transformer. In addition all superconducting coils are operated in the steady state and pulsed fields are generated only by copper coils.

36543 Production of a homogeneous magnetic field in the GOL-1 device. Podyminogin, A.A.; Tauber, M.V. (Institute of Nuclear Physics, Siberian Branch, Academy of Sciences of the USSR, Novosibirsk). *Sov. Phys. - Tech. Phys. (Engl. Transl.);* **22**: No. 9, 1078-1082(Sep 1977).

A magnetic field of 30 kOe is produced by a solenoid with a single-layer winding l=7.3 m long with an inside diameter d=20 cm. At the ends of this solenoid there are mirror windings with a mirror ratio K=1.6. The power supply for the solenoid is a 1.5-MJ capacitor bank. This bank consists of 865 type IM-150/5 capacitors and is divided into 24 sections, each containing 36 capacitors. The currents of the various sections are switched to the solenoid by rectifier-type trigatrons. The peak current is 270 kA (0.5T≅7.5 msec). A homogeneous magnetic field of 30 kOe is produced over a volume of 225 liters.

36544 Superconductor required for thermonuclear fusion. Parain, J. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Physique des Particules Elementaires). *Rev. Phys. Appl.;* **12**: No. 8, 1111-1119(Aug 1977). (In French).

From National congress on plasma physics; Paris, France (6 Dec 1976).

The magnetic systems for large tokamaks are described. The use of superconducting coils will become essential for the next generation of tokamaks. The problems raised by these projects in the present state of superconducting magnet technology are estimated. A superconducting version of a tokamak is described in detail and in particular, the problems encountered with the conductor design are discussed.

36545 Rotational transform angle of the stellarator field with twisted coils. Ohasa, K.; Miyamoto, K. (Nagoya Univ. (Japan). Inst. of Plasma Physics). *Jpn. J. Appl. Phys.;* **16**: No. 5, 813-816(May 1977).

The stellarator field produced by a system of twisted coils in a linear configuration is studied analytically. The current of this system can be represented by the superposition of the azimuthal and helical components. The rotational transform angle of this system is analyzed. It is found that the fundamental harmonic helical components of the current distribution gives the major contribution to the rotational transform angle. The numerical results in the case of the toroidal configuration are compared with analytical ones.

36546 Optimum design of control coils in a tokamak device by nonlinear optimization. Toi, K.; Takeda, T. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). *Jpn. J. Appl. Phys.;* **16**: No. 2, 325-334(Feb 1977).

In a large tokamak device for the next stage of fusion research, it seems that the equilibrium of the toroidal plasma is maintained essentially by control coils excited by an external power supply instead of the currently used conducting casing. This paper describes with some examples a method which is based upon the nonlinear optimization, to design the control coils for the maintaining magnetic field of a tokamak. The optimum configurations of the control and primary coils subject to the technical requirements are successfully obtained by solving the nonlinear optimization problem with some constraints. It is concluded that the method is effective for the design of control coils and also that of the primary coils in a practical tokamak; moreover, the equilibrium configurations of the tokamak plasma without the conducting casing can be obtained easily by using the nonlinear optimization procedure in conjunction with the virtual casing principle by Shafranov and Zakharov.

36547 Aluminum-stabilized multiplex superconductor and magnet. Nomura, H. (Electrotechnical Lab., Tanashi, Tokyo (Japan). Tanashi Branch); Terao, K.; Sakai, T. *Denshi Gijutsu Sogo Kenkyusho Iho;* **41**: No. 2, 107-131(Feb 1977). (In Japanese).

A newly developed high-purity aluminum-clad multiplex superconductor has a higher stability than existing ones in both d. c. and a. c. cases, eliminating the coupling current by insulating and transposing each wire. The multiplex superconductor is found superior in rho/K, electrical resistivity/thermal conductivity, which plays an important role in stabilizing and protecting the superconductor and magnet. Using the above-mentioned wire, a magnet has been constructed. It is 1/3 in volume 1/10 in weight and twice in current density, and its cooling time is shortened, in comparison with the copper-clad magnet of almost the same quality. The wire is widely applicable to such magnets as those used for conveyances.

POWER SUPPLIES, ENERGY STORAGE

36548 Study of superconducting switch using semiconductor stabilizer. Nomura, H. (Electrotechnical Lab., Tanashi, Tokyo (Japan). Tanashi Branch); Houchido, Y.; Sakai, T. *Denshi Gijutsu Sogo Kenkyusho Iho;* **41**: No. 2, 213-226(Feb 1977). (In Japanese).

A new type of superconducting switch for energy storage systems is under development. It is composed of a non-matrixed superconductor and uses a semiconductor as a current separation element, so that it is smaller in size and lower in cost in comparison with ordinary types of similar kind of switches made of copper-stabilized superconductors. Of a new type of switch element using InSb as a current separation element, the electric and thermal characteristics at low temperature are measured and the results are given.

COOLING SYSTEMS

REFER ALSO TO CITATION(S) 36525

36549 Plasma physics research aided by axial flow valve. Foote, V.S. Jr. (Princeton Plasma Physics Lab., NJ). *Heat., Piping Air Cond.;* **51**: No. 12, 5356(Dec 1977).

The cooling of the coils and electrical and electronic equipment at the Princeton Plasma Physics Laboratory is accomplished by a closed system circulating up to 2800 gpm of deionized water at 140 psi, chilled to 11°C. The pulsed heat load, 45 MBtu maximum, is removed by a cascaded pair of 1825 ton centrifugal chillers and is carried by the process water system to a 75 MBtu cooling tower. A description of this system is given. (MOW)

36550 Magnetic field effects on electrochemical reactions occurring at metal/flowing-electrolyte interfaces. Kelly, E.J. (Oak Ridge National Lab., TN). *J. Electrochem. Soc.;* **124**: No. 7, 987-994(Jul 1977).

A study was made to determine whether a magnetic field, such as that associated with a thermonuclear reactor, might adversely affect the corrosion behavior of metallic surfaces in contact with a flowing electrolyte. In metal/flowing-electrolyte systems, electrochemical reactions dependent on the metal/electrolyte interfacial potential difference are affected by an applied magnetic field as a consequence of the Lorentz forces acting on the charged components of the flowing electrolyte. A theoretical analysis of the magnetic field effect was developed, and its validity established by experiments involving the Ti/H_2SO_4 (H_2-saturated) system. Quantitative agreement between theoretical and experimental results was obtained for the electrochemical behavior of Ti in 1N H_2SO_4 (mean flow velocity: 0 to 650 cm/sec) over the available range of magnetic flux density (0 to 2.1 Tesla). Although the experimental work employed discrete Ti electrodes set in the wall of nonconducting Pyrex glass pipe, the theory was extended to include metallic pipes, i.e., the "conducting-wall" case, for which case the "wall-shorting" effect was shown to be negligible. In addition to the adverse effect of a magnetic field on the "uniform" corrosion behavior of metals, the imposition of a magnetic field can also result in enhanced susceptibility to stress corrosion cracking, localized (pitting or crevice) corrosion, oxidation and reduction of solution species, and electrochemical decomposition of the electrolyte. The aforementioned processes, to name a few, are all potential dependent and, consequently, subject to the magnetic field effect.

HEATING AND FUELING SYSTEMS

36551 (COO—2234-12) **Pellets for fusion reactor refueling. Annual progress report, January 31, 1977—January 31, 1978.** (Illinois Univ., Urbana (USA). Fusion Technology Lab.). 1978. Contract EY-76-S-02-2234. 41p. Dep. NTIS, PC A03/MF A01.

Portions of document are illegible.

Progress during the past year has occurred in the following areas. A pellet generator for larger pellets is currently under construction. Alternate pellet generation techniques are under investigation. Progress has been made on the pellet selection and acceleration scheme for the large pellet generator. Work has begun on ablation acceleration for accelerating pellets to very high velocities. In the area of pellet-plasma interactions work has been completed on a transonic flow model and papers have been published dealing with both experimental and theoretical aspects of the problem.

36552 (IPP—4/151) **Construction of the pellet source for the W II b stellarator and first phase of operation.** Amenda, W. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)). Mar 1977. 33p. (In German). Dep. NTIS (US Sales Only), PC A03/MF A01.

In plasma experiments the use of a laser plasma source for filling the magnetic field configuration promises to provide an interesting solution. By bombarding a free-falling deuterium pellet with a high-energy laser beam it is possible to produce a plasma in short time. The problems involved are being investigated in the W II b stellarator. The aim here is to improve a cutting-type pellet source and instal it at the stellarator so as to ensure reliable pellet operation. This calls primarily for a reduction of the cooling capacity and possible temperature regulation with sufficiently exact temperature measurement. This is of importance in producing reproducible, short pellets (down to 4OO μm) with a certain repetition rate and with small dispersion in the plane of incidence.

36553 (UCRL—79732) **Acceleration of solid macro-particles by laser produced ablation.** McCann, T.E.; DeGroot, J.S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 20 Sep 1977. Contract W-7405-ENG-48. 19p. (CONF-771136—21). Dep. NTIS, PC A02/MF A01.

From Annual American Physical Society meeting; Atlanta, GA, USA (7 Nov 1977).

The laser acceleration of small (mass of order 1 gram) solid particles has been computationally analyzed. Acceleration is caused by a one sided laser illumination of a solid particle producing heating of the material, an ablation wave and the resulting ablative reaction force. Laser intensity is constrained to produce an ablation pressure less than the yield strength of the material (typically a few kbar). Preliminary results indicate the possibility of converting absorbed laser energy to solid density kinetic energy with an efficiency greater than 10 percent. Results of LASNEX calculations and comparison with an analytical model are presented which characterize the physics important to the process.

36554 Gas discharge ion source. I. Duoplasmatron. Bacon, F.M. (Sandia Laboratories, Albuquerque, New Mexico 87185). *Rev. Sci. Instrum.;* **49**: No. 4, 427-434(Apr 1978).

The effects of the plasma expansion cup on the operation of a duoplasmatron ion source have been investigated by measuring the total ion current and the distributions of the ion energy, mass, and current density. A copper expansion cup did not affect the magnetic field near the anode of the ion source and consequently the ion current density distribution was sharply peaked near the center of the cup. Ion energy distributions were approximately symmetrical about anode potential. The dominant ionic species were D^+_3 and D^+ at low and high arc currents, respectively. Changes in the electrical potential of the copper cup with respect to the anode produced negligible changes in the above data. A mild steel plasma expansion cup caused the magnetic field to diverge and intercept the cup walls, resulting in ion current density distributions that were flatter and more amenable to focusing than the ones with the copper cup. With the steel cup at anode potential, the ion mass distribution was similar to that from the copper cup; however, the ion energy distribution was asymmetrical about the anode potential with a peak about 10-20 V above anode potential. The total ion current from this mode of operation was about one-third the value from the copper cup. If the steel cup assumed floating potential, about 50 V below anode potential, the total current increased to the level observed from the copper cup and the ion energy distribution was similar to that observed with the copper cup but the current density distribution was much flatter than that of the copper cup. The ion mass distribution was 60%-70% atomic ions over the entire arc current range investigated. Based on these data, a modified plasma expansion cup was designed with tapered steel walls lined with a boron nitride insert. The overall performance of the duoplasmatron ion source with this cup was superior to any of the previous three modes of operation.

36555 Gas discharge ion source. II. Duopigatron. Bacon, F.M.; Bickes, R.W. Jr.; O'Hagan, J.B. (Sandia Laboratories, Albuquerque, New Mexico 87185). *Rev. Sci. Instrum.;* **49**: No. 4, 435-439(Apr 1978).

Ion source performance characteristics consisting of total ion current, ion energy distribution, mass distribution, and ion current density distribution have been measured for several models of a duopigatron. Variations on the duopigatron design involved plasma expansion cup material and dimensions, secondary cathode material, and interelectrode spacings. Of the designs tested, the one with a copper and molybdenum secondary cathode, and a mild steel plasma expansion cup proved to give the best results. The ion current density distribution was peaked at the center of the plasma expansion cup and fell off to 80% of the peak value at the cup wall for a cup 15.2 mm deep. A total ion current of 180 mA consisting of 60%-70% atomic ions was produced with an arc current of 20 A and source pressure of 9.3 Pa. More shallow cups produced a larger beam current and a more sharply peaked ion current density distribution. Typical ion energy distributions were bellshaped curves with a peak 10-20 V below anode potential and with ion energies extending 30-40 V on either side of the peak.

36556 High power electron tubes for plasma heating. Guenard, P.; Palluel, P. (Thomson-CSF, 75 - Paris (France)). *Rev. Phys. Appl.;* **12**: No. 8, 1163-1170(Aug 1977). (In French).

From National congress on plasma physics; Paris, France (6 Dec 1976).

In view of applications, such as plasma heating, which require, at more or less high frequencies, very high powers (10 kW-1 MW) discussed in this paper are the power capabilities (as a function of frequency) of various well known types of tubes: triodes and tetrodes, klystrons, TWT's, and amplitrons; and of a new development: the gyrocone. As a whole, these tubes can deliver powers of at least 1 MW up to about 10 GHz. Beyond this frequency, the power drops down very rapidly and falls below 1 kW at 100 GHz. However, this limit may be pushed beyond 300 GHz by using cyclotron resonance tubes.

36557 New lens system using toroidal magnetic field for intense ion beam. Mohri, A.; Ikuta, K.; Fujita, J. (Nagoya Univ. (Japan). Inst. of Plasma Physics). *Jpn. J. Appl. Phys.;* **16**: No. 3, 491-496(Mar 1977).

The use of a toroidal magnetic field as a lens system is proposed for producing an intense ion beam. The characteristics of

the lens system are obtained both analytically and numerically. Some examples of ray-trajectories are presented for different focal lengths. The system is applicable to neutral beam injection heating and micro-pellet implosion for nuclear fusion, and to other fields such as ion beam x-ray lasers.

36558 **Magnetic topography in duoplasmatron ion sources.** Ciuti, P. (Trieste Univ. (Italy). Istituto di Fisica). *Energ. Nucl. (Milan);* **24**: No. 2, 89-96(Feb 1977).

A short description is at first given in this article of the characteristics of the discharge and of the plasma generated in a duoplasmatron ion-source. Then the different magnetic topographies usually employed for such a source are examined. In particular, the "two peak" topography is studied and some basic rules for evaluating the magnetic field intensity in the extraction zone are suggested.

36559 **Charge exchange system.** Anderson, O.A. US Patent Application 743,375. 19 Nov 1976. 13p.

An improved charge exchange system for substantially reducing pumping requirements of excess gas in a controlled thermonuclear reactor high energy neutral beam injector. The charge exchange system utilizes a jet-type blanket which acts simultaneously as the charge exchange medium and as a shield for reflecting excess gas.

TRITIUM PROCESSING, ENVIRONMENT AND SAFETY

36560 (ANL/FPP—77-2, pp 50-57) **TNS project.** 1977.

In Fusion Power Program quarterly progress report, April—June 1977.

This project is considered according to the following four areas of research: (1) tritium facility conceptual design study, (2) neutral beam heating, (3) neutral beam pumping, and (4) penetration shield analysis. (MOW)

36561 (MLM—2500) **Tritium Systems Test Facility.** Cafasso, F.A.; Maroni, V.A.; Smith, W.H.; Wilkes, W.R.; Wittenberg, L.J. (Mound Facility, Miamisburg, Ohio (USA)). 22 Feb 1978. Contract EY-76-C-04-0053. 105p. Dep. NTIS, PC A06/MF A01.

This TSTF proposal has two principal objectives. The first objective is to provide by mid-FY 1981 a demonstration of the fuel cycle and tritium containment systems which could be used in a Tokamak Experimental Power Reactor for operation in the mid-1980's. The second objective is to provide a capability for further optimization of tritium fuel cycle and environmental control systems beyond that which is required for the EPR. The scale and flow rates in TSTF are close to those which have been projected for a prototype experimental power reactor (PEPR/ITR) and will permit reliable extrapolation to the conditions found in an EPR. The fuel concentrations will be the same as in an EPR. Demonstrations of individual components of the deuterium-tritium fuel cycle and of monitoring, accountability and containment systems and of a maintenance methodology will be achieved at various times in the FY 1979-80 time span. Subsequent to the individual component demonstrations--which will proceed from tests with hydrogen (and/or deuterium) through tracer levels of tritium to full operational concentrations--a complete test and demonstration of the integrated fuel processing and tritium containment facility will be performed. This will occur near the middle of FY 1981. Two options were considered for the TSTF: (1) The modification of an existing building and (2) the construction of a new facility.

36562 **Hydrogen-isotope permeation barrier.** Maroni, V.A.; Van Deventer, E.H. (to Energy Research and Development Administration). US Patent 4,031,921. 28 Jun 1977. Filed date 9 Sep 1975. 6p. PAT-APPL-611,722.

A composite including a plurality of metal layers has a Cu-Al-Fe bronze layer and at least one outer layer of a heat and corrosion resistant metal alloy. The bronze layer is ordinarily intermediate two outer layers of metal such as austenitic stainless steel, nickel alloys or alloys of the refractory metals. The composite provides a barrier to hydrogen isotopes, particularly tritium that can reduce permeation by at least about 30 fold and possibly more below permeation through equal thicknesses of the outer layer material.

POWER CONVERSION SYSTEMS

36563 **Computer simulation of the periodic electrostatic focusing converter.** Barr, W.L.; Howard, B.C.; Moir, R.W. (Univ. of California, Livermore). *IEEE Trans. Plasma Sci.;* **PS-5**: No. 4, 248-258(Dec 1977).

A computer study was made of the various physical processes that take place in the periodic electrostatic focusing, direct energy converter. Computer simulation techniques are described and the results are presented. The effect that space charge, secondary electrons, beam size, charge exchange, and ionization have on conversion efficiency is examined. The results are applied to the design of a reactor. Finally, future plans for studies of direct converters are discussed.

INERTIAL CONFINEMENT TECHNOLOGY

REFER ALSO TO CITATION(S) 35811, 35812, 35813, 35814, 35815, 35816, 35817, 35818, 35819, 35820, 36327, 36365

36564 (IAEA—200) **Technology of inertial confinement experiments.** Mayer, F.J. (International Atomic Energy Agency, Vienna (Austria)). 1976. 259p. (CONF-760723—). Dep. NTIS (US Sales Only), PC A12/MF A01.

From Advisory group meeting on the technology of inertial confinement experiments; Dubna, USSR (19 Jul 1976).

Abstracts for each paper have been entered into the data base. (MOW)

36565 (IAEA—200, pp 233-239) **High-power laser system for thermonuclear fusion experiments.** Azizov, Eh.A.; Ignat'ev, L.P.; Koval'skii, N.G.; Kolesnikov, Yu.A.; Mamzer, A.F.; Pergament, M.I.; Rudnitskii, Yu.P.; Smirnov, G.V.; Yagnov, V.A.; Nikolaevskii, V.G. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1976.

From Advisory group meeting on the technology of inertial confinement experiments; Dubna, USSR (19 Jul 1976).

In Technology of inertial confinement experiments. Proceedings of an advisory group meeting organized by the IAEA held in Dubna, USSR, 19-23 July 1976.

A high-power laser system has been designed for an energy output of approximately $3X10^4$J. Neodymium glass was selected based on the level of technical progress, operating experience and the availability of components. The operating performance that has been achieved to date is described.

36566 (IAEA—200, pp 25-39) **Transport and focusing of high-current relativistic electron beams onto a target.** Bakshaev, Yu.L.; Baranchikov, E.I.; Gordeev, A.V.; Koba, Yu.V.; Korolev, V.D.; Pen'kina, V.S.; Smirnov, V.P.; Sukhov, A.D.; Tarumov, E.Z. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1976.

From Advisory group meeting on the technology of inertial confinement experiments; Dubna, USSR (19 Jul 1976).

In Technology of inertial confinement experiments. Proceedings of an advisory group meeting organized by the IAEA held in Dubna, USSR, 19-23 July 1976.

Investigations of the focusing of high-current relativistic electron beams for achieving a pulsed thermonuclear reaction have been made on the URAL and MS accelerators. Injection and transport of a disk-type electron beam into a cusp magnetic field allows approximately $> 25\%$ of the beam to be deposited onto the surface of a centrally located target. With co-axial lines electron beams have been focused onto targets with 85% efficiency. The mechanism for sharp and effective focusing by pin-type cathodes is discussed.

36567 (SAND—77-0157, pp 85-92) **Laser-fusion-related studies.** May 1977.

In Laser-fusion research progress report, July—December 1976.

Some critical processes in laser fusion plasma are discussed. The experimental program utilized a weakly focused (f/8.7) 1.06-μm, 50-ps duration laser beam irradiating thin film targets of polystyrene. Preliminary results indicate enhanced absorption with p-polarized light. Several techniques were used to gage the absorption; ion energy measurements using Faraday cups, analysis of the ion distribution function and the amount of target mass which is heated. (MOW)

36568 **Magnetic field transport in laser-fusion targets.** Langdon, A.B. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *Phys. Fluids;* **21**: No. 4, 705-706(Apr 1978).

The spatial extent of magnetic field sources in laser-irradiated targets can be small enough for the well-known nonlocal nature of plasma conductivity to strongly affect magnetic field diffusion and saturation.

36569 **Laser-fusion experiments utilizing a 4π illumination system.** Storm, E.K.; Swain, J.E.; Ahlstrom, H.G.; Boyle, M.J.; Rupert, V.C.; Phillion, D.W. (Lawrence Livermore Laboratory, University of California, Livermore, California 94550). *J. Appl. Phys.;* **49**: No. 3, 959-964(Mar 1978).

A focusing system which utilizes two f/0.47 doublets in conjunction with ellipsoidal mirrors produces two focusing cones with half-angles of 81.5°. This system has been used with the Lawrence Livermore Laboratory Janus 1.06-μm laser to irradiate and implode DT-filled glass microshells of $\sim$70 μm diameter. The purpose of the system was to provide more uniform heating of the pusher and more uniform compression of the DT fuel than had been obtained when irradiating targets using f/1 lenses. Neutron yields of $\sim 10^7$ per event have been obtained at power levels of $\sim$0.4 TW. X-ray micrographs show that improved uniformity of heating and implosion sphericity are achieved. Data are also presented which

add further confirmation of the importance of absorption by plasma wave resonance for non-normal incidence of the laser light on the target surface.

36570 High speed waveform measurements in laser fusion research. Farley, H. (Tektronix Inc., Beaverton, OR). *Res./Dev.;* **29**: No. 1, 42-44, 47-48(Jan 1978).

Some critical measurements that need to be made in laser fusion research are described. The electronic instruments available for these measurements are outlined along with their usage. (MOW)

36571 Research with laser. Key, M.H.; Lewis, C.L.S. (Queen's Univ., Belfast). *Indian East. Eng.;* **119**: No. 10, 491-493(Oct 1977).

At present, world-wide interest focuses particularly on the irradiation of solid targets with high-power neodymium glass laser beams, because the highest power yet available from a laser is obtained from neodymium lasers. Other types might be preferred in the future, either from technological considerations or from those of wavelength or pulse duration. This article deals largely with neodymium glass lasers and the background to the new UK laboratory, the Science Research Council Laser Centre, for work with them.

36572 Angle amplifying optics using plane and ellipsoidal reflectors. Glass, A.J. (to Energy Research and Development Administration). US Patent 4,017,163. 12 Apr 1977. Filed date 16 Apr 1976. 6p. PAT-APPL-677,646.

An optical system for providing a wide angle input beam into ellipsoidal laser fusion target illumination systems is described. The optical system comprises one or more pairs of centrally apertured plane and ellipsoidal mirrors disposed to accept the light input from a conventional lens of modest focal length and thickness, to increase the angular divergence thereof to a value equivalent to that of fast lenses, and to direct the light into the ellipsoidal target illumination system.

36573 Thermonuclear fusion plasma by lasers coupling and implosion. Yamanaka, C.; Yokoyama, M.; Nakai, S.; Yamanaka, T.; Izawa, Y. (Osaka Univ. (Japan)). *Rikagaku Kenkyusho Hokoku;* **4**: No. 4, 32-50(Mar 1977).

From U.S.-Japan seminar on laser interaction with matter; New York, USA (1 - 5 Nov 1976).

The current problems of the laser fusion research are to get fundamental understanding of (i) the coupling of laser-plasma due to various interactions and (ii) the implosion process of pellet targets. To pursuit these objects, the high power laser systems of various wave lengths have been constructed. A glass laser system of 4 beams, "Gekko IV" using a new phosphate glass, LHG-5 has been constructed. The output energy is 1kJ in one nanosecond and 300J in 100 picosecond. The focusable size of each beam is 50μm in diameter. An E-beam controlled CO_2 laser system, "Lekko I" can deliver 500J in nanosecond. The multiband multiline oscillator is tested to increase the energy extraction. Saturation energy of the laser increases about 60%. The PFN capacitor bank is successfully employed to the main pumping discharge with perfect loading. As for the laser-plasma coupling, the importance of resonance absorption, its relation to self generated magnetic fields and high energetic ion jet stream, self modulation of the density profile, and the influence of density scale length on the parametric instability related to the Brillouin backscattering are investigated. Using the lasers of 1μm and 10μm in wave length, we can clarify a scaling law of the interaction processes. A model of generation of fast ion jet stream is examined. The neutron yield in plasma focus is enhanced about two times by a strong absorption of the CO_2 laser beam. As for the implosion experiment, various targets with multi-layers have been studied considering the energy flow of radiation. The enhanced transmission of light is found (Ausaka effect). The compression of deuterium filled microballoon is estimated up to 100. The neutron yield is about 10^5.

36574 Laser implosion. Patou, C. (CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France)). *J. Phys. (Paris), Colloq.;* No. 3, C.79-C.87(1977). (In French).

From National congress on plasma physics; Paris, France (6 - 10 Dec 1976).

The main ideas, the physical processes involved in laser induced implosion and their limitations are related. These are illustrated with the results of numerical calculations. The most important experiments performed in different laboratories are presented.

36575 CO_2 laser fusion effort at Los Alamos Scientific Laboratory. Ladish, J.S. (Los Alamos Scientific Lab., NM). pp 54-65 of Laser 77 opto-electronics. Conference proceedings. Waidelich, W. (ed.). Surrey, Eng.; IPC Science and Technology Press Limited, IPC House (1977).

From Laser opto-electronics conference; Munich, F.R. Germany (20 Jun 1977).

See CONF-7706116—.

Elementary considerations lead one to readily conclude that useful laser fusion energy outputs from D-T pellet implosions will require lasers capable of producing tens of kilojoules to perhaps megajoules in short (i.e., of order a nanosecond) pulses. Four laser systems at the Los Alamos Scientific Laboratory are described; two are currently operating and performing useful target experiments, two will become operational within the next five years. Output energies in these systems range from 150 J in the smallest to 100 kJ anticipated in the largest.

COMPONENT DEVELOPMENT AND MATERIALS TESTING

REFER ALSO TO CITATION(S) 35593

36576 (ANL/FPP—77-2, pp 1-36) **Fusion reactor materials.** 1977.

In Fusion Power Program quarterly progress report, April—June 1977.

The following topics are briefly discussed: (1) surface blistering studies on fusion reactor materials, (2) TFTR design support activities, (3) analysis of samples bombarded in-situ in PLT, (4) chemical sputtering effects, (5) modeling of surface behavior, (6) ion migration in glow discharge tube cathodes, (7) alloy development for irradiation performance, (8) dosimetry and damage analysis, and (9) development of tritium migration in fusion devices and reactors. (MOW)

36577 (DOE/ET—0007) **Alloys for the fusion reactor environment: a technical assessment.** (Department of Energy, Washington, D.C. (USA). Div. of Magnetic Fusion Energy). Jan 1978. 102p. Dep. NTIS, PC A06/MF A01.

This technological assessment involves the following: (1) primary and backup materials of choice, (2) testing and manpower requirements, (3) major milestones, (4) natural resources and industrial capability, and (5) conclusions. The first wall/blanket structure was emphasized in the assessment of materials subject to intense radiation. (MOW)

36578 (EUR-CEA-FC—902) **Estimation of energies necessary to control the plasma position inside a Tokamak (Torus II).** Aymar, R.; Leloup, C.; Pariente, M. (Association Euratom-CEA sur la Fusion, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Physique du Plasma et de la Fusion Controlee). Aug 1977. 59p. (In French). Dep. NTIS (US Sales Only), PC A04/MF A01.

The stability and the amplitude of plasma displacements in a Tokamak are studied. The role of the iron core saturation level and of the vertical field curvature are discussed. Feedback power is calculated for Torus II.

36579 Applied vacuum technology on the field of nuclear fusion. Frey, H.; Polhede, W.; Reiter, R. *VDI (Ver. Dtsch. Ing.) Z.;* **119**: No. 19, 929-932(Oct 1977). (In German).

Vacuum vessels of ever increasing dimensions are required for nuclear fusion experiments. Thereby, one must consider in connection with the manufacture that the reactive effect of the vessel wall on the plasma is of paramount importance. Every contamination, particularly by heavy elements, results in an increase of the radiation losses causing the plasma to cool down. Apart from the development and the construction of large reaction vessels, special efforts must be undertaken in the field of the vacuum systems with regard to large pump performances for hydrogen and its isotopes, respectively.

36580 Dense plasma focus - a high intensity neutron source. Bernard, A.; Coudeville, A.; Jolas, A. (CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France)); Cloth, P.; Conrads, H. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.)); Gourlan, G.; Maisonnier, Ch.; Rager, J.P. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Lab. Gas Ionizzati). *Nucl. Instrum. Methods;* **145**: No. 1, 191-218(15 Aug 1977).

The dense plasma focus formed under special conditions at the open end of a coaxial accelerator is considered as a plasma neutron source the versatility of which is still unexplored. The neutron yield in space and time as well as the neutron spectrum are determined by the local parameters of the plasma and the surrounding fusionable gas. The physics governing these parameters together with the diagnostics for measuring these quantities are treated in detail. The engineering problems associated with the creation, compression and heating of the plasma are described in particular. Two different types of energy storage systems, a capacitive one and an inductive one are discussed. As examples two devices already in operation are described in detail: one for particular high neutron yield per discharge (10^{13} dd-neutrons) and one for high repetition rates (two discharges per second at a yield of 6×10^9 dd-neutrons per discharge). Finally the perspectives for developing the plasma focus as a neutron source with a flux of 14 MeV neutrons beyond 10^{15} neutrons/cm^{2}s are discussed.

36581 Potential mirror concepts for radiation testing of fusion reactor materials. Miley, G.H. (Illinois Univ., Urbana (USA). Fusion

Studies Lab.). *Nucl. Instrum. Methods;* **145**: No. 1, 169-177(15 Aug 1977).

Studies under the University of Illinois PROMETHEUS (Plasma Reactor Optimized for Materials Experimentation for Thermonuclear Energy Usage) project are described that started in 1971 with the realization that a practical fusion-plasma neutron source was feasible with a net-power input (rather than production). The basic objectives were similar to those in later FERF (Fusion Engineering Research Facility) studies: namely, to maximize the neutron flux and usable experimental volume; to include the flexibility to handle a variety of both materials and engineering experiments; to minimize capital and operating costs; and to utilize near- term technology. The PROMETHEUS design provides a neutron flux of approximately 5×10^{14} n/cm^{2}s by injection of approximately 30 MW of neutral-beams into a 20 cm radius mirror-confined plasma. Charge-exchange bombardment of the first wall is viewed as a key problem in the design and is discussed in some detail. To gain yet higher neutron fluxes for accelerated testing, two alternate designs have been studied: a 'Twin-beam' injection device and a field reversed mirror concept. The latter potentially offers fluxes approaching 10^{16} n/cm^{2}s but involves more speculative technology.

36582 **Laser Solenoid Radiation Test Facility.** Steinhauer, L.C. (Mathematical Sciences Northwest, Inc., Bellevue, Wash. (USA)). *Nucl. Instrum. Methods;* **145**: No. 1, 157-168(15 Aug 1977).

The Laser Solenoid Radiation Test Facility (LSRTF) is a concept based on a pulsed plasma source of neutrons, alpha particles, and bremsstrahlung and is characterized by a moderate radiation flux and a large test sample volume. The LSRTF is intermediate in its size, technology, and availability (1985-1990), and consequently has potential for bridging the gap between small present day accelerator-target sources and a large pulsed plasma engineering research facility in the 1990's. It also has important potential as a compact engineering test reactor for realistic operational testing of integrated subsystems for a linear fusion reactor. Its design, performance and operating characteristics are discussed in the present paper. The necessary development programs to bring such a facility into timely operation are also described.

36583 **High energy-high intensity neutron sources for fusion technology and radiotherapy applications.** Ullmaier, H. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Festkoerperforschung); Behrisch, R. (Max-Planck-Institut fuer Plasmaphysik, Garching/Muenchen (Germany, F.R.)); Barschall, H.H. (Wisconsin Univ., Madison (USA). Dept. of Nuclear Engineering). *Nucl. Instrum. Methods;* **145**: No. 1, 1-7(15 Aug 1977).

This introductory paper is placed in front of the contributions to this special issue instead of a preface. The article gives a brief review of the problems whose investigation and solution require intense high energy neutron generators. An economic strategy for the future development of high intensity sources is also proposed.

36584 **Plasma focus as a large fluence neutron source.** Zucker, O.; Bostick, W.; Long, J.; Luce, J.; Sahlin, H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). *Nucl. Instrum. Methods;* **145**: No. 1, 185-190(15 Aug 1977).

A continuously operated, 1 pps, dense-plasma-focus device capable of delivering a minimum of 10^{15} neutrons per pulse for material testing purposes is described. With ^{5}I scaling, predicted from analysis of existing machines, yields of 10^{16}-10^{17} neutrons per pulse are postulated. The average power consumption, which has become a major issue as a result of the energy crisis is shown to be highly favorable. A novel approach to the capacitor bank and switch design allowing repetitive operation is discussed.

36585 **Sputtering yield measurement on first wall materials of thermonuclear fusion devices.** Sone, K.; Ohtsuka, H.; Abe, T.; Yamada, R.; Obara, K. (Japan Atomic Energy Research Inst., Tokai, Ibaraki. Tokai Research Establishment). *Shinku;* **20**: No. 4, 136-141(Apr 1977). (In Japanese).

A new technique specially designed to use Auger electron spectroscopy for the measurement of very low sputtering yield has been applied for low energy (0.1-6 keV) proton sputtering of molybdenum and pyrolytic graphite. In molybdenum the sputtering yield above 1 keV is about three times as large as the experimental one obtained by Einfgeld, and below 1 keV it rapidly decreases with decreasing energy. In graphite physical sputtering yield at 500°C is about an order of magnitude than that of molybdenum, whereas the energy dependence is very similar to the molybdenum case. But the energy dependence is very different from the theory of Weissmann and Sigmund. The measured temperature dependence of the chemical sputtering yield for pyrolytic graphite at 1 keV shows the maximum value of about 0.08 CH_4 molecules/ion near 750 K.

36586 **First-wall coatings for tokamak fusion reactors.** Langley, R.A.; Prevender, T.S. (Sandia Labs., Albuquerque, NM). *Thin Solid Films;* **45**: 235-245(1977).

The coating of the first wall of a fusion reactor must withstand an intense neutron flux, the impact of energetic charged and neutral particles, and photons, all of which escape from the plasma. Penetration of material eroded from the first-wall coating into the plasma will have a detrimental effect on the plasma stability and energy balance. Therefore material selection for the first-wall coating of a fusion reactor represents one of the critical problem areas for the achievement of fusion power. Theoretical and experimental studies which have been conducted on the many facets of the problem are reviewed with special emphasis placed on the more critical aspects. Possible directions of future research in this area are outlined.

GENERAL AND MISCELLANEOUS

MANAGEMENT

36587 (HMI—224) **Report of scientific results 1976. Section nuclear chemistry and reactor.** (Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (Germany, F.R.). Bereich Kernchemie und Reaktor). 1976. 186p. (In German). Dep. NTIS (US Sales Only), PC A09/MF A01.

The report of the section Nuclear Chemistry and Reactor presents the results of R and D in the fields of neutron scattering, radiation damage in solids, reactor chemistry, trace elements research in biomedicine, geochemistry, reactor operation, radioisotope production, and gives a survey of publications and lectures.

MATHEMATICS AND COMPUTERS

REFER ALSO TO CITATION(S) 35339, 35341, 35342, 35345, 35347, 35348, 35360

36588 (CONF-7510172—P2, pp 757-767) **Midas Processor.** Kriegler, F.J.; Gordon, M.F.; McLaughlin, R.H.; Marshall, R.E. (Environmental Research Inst. of Michigan, Ann Arbor). 1975.

From 10. international symposium on remote sensing of environment; Ann Arbor, MI, USA (6 Oct 1975).

In Proceedings of the tenth international symposium on remote sensing of environment.

The MIDAS Processor (Multivariate Interactive Digital Analysis System) is a high speed, interactive processor intended to process multi-band data quickly and economically to meet the anticipated needs of those who use remotely sensed data, particularly from very large areas. MIDAS is designed, for example, to process single or multitemporal ERTS frames into the categories in less than a minute and provide a color hard copy in a few minutes. MIDAS consists of a fast multi-pipeline preprocessor and classifier, an interactive color display and color printer, and a medium scale computer system for analysis and control. A software operating system has also been designed to allow analysis and control of the processing by the user with relatively little familiarity with the system. The system is designed to process data having as many as 16 spectral bands per picture element at rates of 200,000 picture elements per second into as many as 17 classes using a maximum likelihood decision rule. The output data may be viewed on a 512 x 512 color CRT display or printed on a 1000 x 1400 ink-jet color printer. The data may be stored on disc or tape for further processing, as well. The system can accept data from standard digital tapes, high density digital tape or analog tapes. The MIDAS system has been designed and built over the past two years under the sponsorship of the NASA/AAFE program with technical monitoring by the NASA Langley Research Center. Present plans are to begin use of the system in a variety of applications, particularly such programs as the LACIE (Large Area Crop Inventory Experiment) and large area aircraft survey programs.

36589 (UCID—17760) **Algebraic simplification of interconnected systems.** Hegner, S.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 31 Mar 1978. Contract W-7405-ENG-48. 72p. Dep. NTIS, PC A04/MF A01.

The development of strategies for simplification of large-scale interconnected systems by substituting, in the model, components which are simpler than the original ones is discussed. First, a general framework for discussing interconnection and interconnective modeling is developed, based upon the concepts of universal algebra. Then the simplification of systems which may be described by use of matrices over a semiring is investigated in detail. Examples of such systems include the behaviors of multi-input, multi-output linear systems.

36590 **Perspective displays for three-dimensional finite difference calculations.** Hirt, C.W.; Cook, J.L. (Los Alamos Scientific Lab., NM). *Comput. Fluids;* **3**: 293-303(1975).

A new technique was developed for the presentation of data obtained in three-dimensional finite difference calculations. The technique consists of an especially simple and efficient method for the generation of perspective pictures with hidden lines removed. These pictures may contain distributions of marker particles, velocity vectors, contour lines, streak-lines, etc., in relation to an array of prismatically shaped obstacles. With this technique the gross features of many complex three-dimensional problems can be readily understood.

36591 (UCID—30158(Rev.1)) **Vector programming tools and techniques.** Litterst, R.; Long, G.; McMahon, F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Dec 1977. Contract W-7405-ENG-48. 232p. Dep. NTIS, PC A11/MF A01.

This is a guide to programming for the STAR-100. It describes the STAR instruction set, the implementation of that set in the LRLTRAN language, and the tradeoffs one must make to write codes that meet design goals and run fast on the STAR. It describes the software available: system libraries, the BCON interpreter, mathematical subroutines, graphics routines, and debugging aids. Discussions of the hardware, memory, operating system, and STAR number system are given as background to illustrate good practice in planning the layout of memory and in doing input/output. It should be noted that BLIB and STARLIB are undergoing massive changes. Macro names, subroutine availability, etc., described in this report may or may not exist in the future. 72 figures, 14 tables.

36592 Asymptotic behavior of group integrals in the limit of infinite rank. Weingarten, D. (Physics Department, Indiana University, Bloomington, Indiana 47401). *J. Math. Phys. (N.Y.);* **19**: No. 5, 999-1001(May 1978).

We show that in the limit $N \to \infty$ integrals with respect to Haar measure of products of the elements of a matrix in SO(N) approach corresponding moments of a set of independent Gaussian random variables. Similar asymptotic forms are obtained for SU(N) and Sp(N). An application of these results to Wilson's formulation of lattice gauge theory is briefly considered.

36593 Variational method and Mathieu equation. Hsieh, D.Y. (Division of Applied Mathematics, Brown University, Providence, Rhode Island 02912). *J. Math. Phys. (N.Y.);* **19**: No. 5, 1147-1151(May 1978).

A variational method is developed to study the linear and nonlinear Mathieu equations. For the linear Mathieu equation, various modes of the Mathieu functions, the characteristic curves, and the stability regions are found, which agree with the established results. The variational method is then applied to the nonlinear Mathieu equation. Approximate periodic solutions of various modes are found in a similar manner, and their stability also investigated.

36594 Diagonal dominance arguments for bounding [norm(A^{-1})]/sub infinity/. Varga, R.S. (Kent State Univ., OH). *Linear Algebra Its Appl.;* **14**: 211-217(1976).

In a recent paper by Varah [Linear Algebra Appl. 11: 3-5 (1975)], an upper bound for [norm (A^{-1})]/sub infinity/ was determined, under the assumption that A is strictly diagonally dominant, and this bound was then used to obtain a lower bound for the smallest singular value for A. In this note, this upper bound for [norm(A^{-1})]/sub infinity/ is sharpened and extended to a wider class of matrices. This bound is then used to obtain an improved lower bound for the smallest singular value of a matrix.

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DOE Energy Information Data Base: Corporate Author Entries (TID-4585) is used in the standardization of corporate entries. TID-4585 is available for purchase from the National Technical Information Service (NTIS), U. S. Department of Commerce, Springfield, Virginia 22161.

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Title, (supplementary information), citation number, (report number)

The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processses applied to, the subject term.

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3	3:35104	*See* INIS-mf-3900
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CONF-7609165-	(Proceedings of the joint MMIJ-AIME meeting, Denver, CO, USA, 1-3 Sep 1976)	
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CONF-770369-	(NAEG Pu program report meeting, Las Vegas, NV, USA, 2-4 Mar 1977)	
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CONF-770505-	(International conference on nuclear power and its fuel cycles, Salzburg, Austria, 2-13 May 1977)	
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CONF-7705105-	(National powder metallurgy conference, Detroit, MI, USA, 24-25 May 1977)	
	3:35546	Princeton, NJ; Metal Powder Industries Federation (1977). $42.00
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10	3:36526	Dep. NTIS, PC A02/MF A01
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11	3:35987	*See* IAEA-SM-222-10
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CONF-780110-		(11. symposium on radiation instrumentation, San Diego, CA, USA, 17-19 Jan 1978)
9	3:35896	*See* LA-UR-78-48
CONF-780113-		(3. conference on RF plasma heating, Pasadena, CA, USA, 11-13 Jan 1978)
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October 1977

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